



e-ISSN: 2319-8753 | p-ISSN: 2347-6710

IJRSET

International Journal of Innovative Research in
SCIENCE | ENGINEERING | TECHNOLOGY



INTERNATIONAL JOURNAL OF INNOVATIVE RESEARCH

IN SCIENCE | ENGINEERING | TECHNOLOGY

Volume 13, Issue 11, November 2024

ISSN INTERNATIONAL
STANDARD
SERIAL
NUMBER
INDIA

Impact Factor: 8.524

 9940 572 462

 6381 907 438

 ijirset@gmail.com

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Enhanced Detection of Identification of Skin Cancer Melanoma through Deep Learning Models: A Comparative Approach

Tejaswini S, Usha A, Sumana N

Assistant Professor, Department of Artificial Intelligence and Data Science Engineering, CIT, Gubbi, Tumkur, Karnataka, India

U.G. Student, Department of Artificial Intelligence and Data Science Engineering, CIT, Gubbi, Tumkur, Karnataka, India

U.G. Student, Department of Artificial Intelligence and Data Science Engineering, CIT, Gubbi, Tumkur, Karnataka, India

ABSTRACT: This study addresses the rising incidence between melanoma and the necessity for accurate, early-stage detection. It presents a deep learning-based, comparing various models to evaluate their efficacy in classifying skin lesions. Using the ISIC dataset and AlexNet as a primary model, augmented with transfer education and data enhancement, this study demonstrates an improvement in the accuracy of classification to 96%. The findings imply that the proposed approach outperforms traditional methods, offering a robust solution for real-time melanoma detection.

KEYWORDS: Identification of Skin Cancer, Melanoma, CNN, Deep Learning, Transfer Learning, ISIC Dataset, Classification Accuracy

I. INTRODUCTION

Skin cancer, specifically melanoma, is a growing health concern worldwide, impacting millions of individuals annually. Melanoma is among the most aggressive and potentially fatal Skin cancer kinds, characterized by its rapid spread to further body parts. If not detected and treated early. The importance of early detection cannot be overstated, as studies show that the survival rate significantly increases with prompt diagnosis and treatment. Traditional methods of detecting skin cancer, including visual inspections, dermoscopy, and biopsy, rely on the expertise of dermatologists, which can be both subjective and time-consuming. As the global incidence of skin cancer continues to rise The demand for automated, efficient, and accurate diagnostic tools to support dermatologists in their clinical decision-making.

Over the past few years, advancements in machine learning and deep learning cleared the way for computer-aided diagnostic systems, which have a lot of promise for the dermatology area. Convolutional Neural Networks and other deep learning models are among the many machine learning techniques, have shown remarkable success in tasks involving picture categorisation. CNNs are highly effective while obtaining hierarchical characteristics from pictures, allowing them to differentiate between several kinds of skin lesions with high accuracy. By training these models using extensive datasets, they can discover how to identify patterns and features that might be difficult to identify by human experts, thereby improving the reliability and skin cancer's rate detection.

This study aims to build upon these advancements by creating a model for deep learning that can classify skin lesions as harmless or malignant, with an emphasis on melanoma. Making use of the ISIC 2018 dataset, [3] this research employs a CNN architecture, enhanced transfer education and data augmentation, to overcome challenges like lack of data and unequal class distribution. By contrasting how well various CNNs perform models, this study seeks to identify the best effective method for detecting melanoma, with the intention of offering a scalable solution that could be integrated into real-world clinical settings. The proposed model is designed to provide high accuracy, thereby supporting dermatologists in making timely and informed decisions for patient care.

II. LITERATURE SURVEY

This research looks into the rapid while employing deep learning (DL) and machine learning (ML) to detect skin cancer techniques. The most notable DL architectures, CNNs, or convolutional neural networks, have become widely adopted because they can automatically identify and extract features from photos of skin lesions, leading to highly accurate classification results. Studies have shown that integrating CNNs with optimization techniques can further enhance detection capabilities. For instance, Kalpana et al. utilized a hybrid Support Vector Kernel and Random Forest approach to categorise skin lesions using improved sensitivity and specificity. Another study by Catal et al. developed a CNN-based model for melanoma segmentation, achieving high precision but still facing challenges with model robustness. This body of work demonstrates a trend hybrid models that incorporate both machine learning and algorithms with CNN architectures, aiming to achieve increased precision and effectiveness in skin cancer detection.[1]

This paper investigates early skin cancer detection through deep learning, focusing on the effectiveness of AlexNet, a pre-trained CNN model, in classifying skin lesions. AlexNet's architecture, particularly its use of multiple convolutional and pooling layers, has proven successful in tasks requiring fine-grained image classification. Previous studies highlight The efficiency of transfer learning with AlexNet, especially when paired with data augmentation techniques to enhance the generalisation of the model across various datasets. Research by Hosny et al. demonstrated how transfer learning applied to AlexNet achieved high accuracy in skin lesion classification, with data augmentation helping address class imbalances common in medical image datasets.[2]

This paper addresses categorisation of skin cancer using deep learning, specifically through a CNN architecture trained on the 2018 ISIC dataset. The use of CNNs in Analysis of medical images has become prevalent, particularly due to their organisational hierarchy, which permits the extraction of both low- and high-level features from images. Previous studies have shown that CNNs, when trained on large and diverse datasets, can successfully differentiate between benign and malignant growths with high accuracy. For example, Hameed et al. achieved notable results in skin lesion classification by using transfer learning in a CNN, which allows models pre-trained on extensive image datasets to be adapted to specialized medical datasets, enhancing performance without extensive additional training.[3]

III. METHODOLOGY

The methodology for this research centers on utilising deep learning methods, in particular, specifically Convolutional Neural Networks (CNNs), to improve melanoma skin cancer detection's precision and effectiveness. The CNN models, including AlexNet and other pre-trained architectures, are fine-tuned through transfer learning, where the models are initially trained on large-scale image datasets and then adapted to the specific task of skin lesion grouping. To enhance the model's adaptability to various lesion types, The training procedure uses techniques for data augmentation such as rotation, scaling, and flipping, which help address data imbalances and increase the robustness of the model in real-world applications. This strategy makes it possible for the models to effectively extract high-level features from dermoscopic images, Differentiating between malignant and benign tumours with improved accuracy.

Performance indicators like precision, accuracy, recall, and F1-score are employed to evaluate the efficacy of each model. The models are trained and validated on the 2018 ISIC dataset, a well-established dataset for a skin injury analysis, which includes a diverse set of labeled signifying many forms of skin cancer types. Comparative analysis is performed to determine the model that provides the best trade-off between accuracy and computational efficiency. Additionally, optimization methods like adaptive learning rates and dropout are employed to prevent overfitting and improve generalization across different lesion images. This methodology ensures that the proposed models are robust, scalable, and capable of supporting real-time melanoma detection in clinical settings.

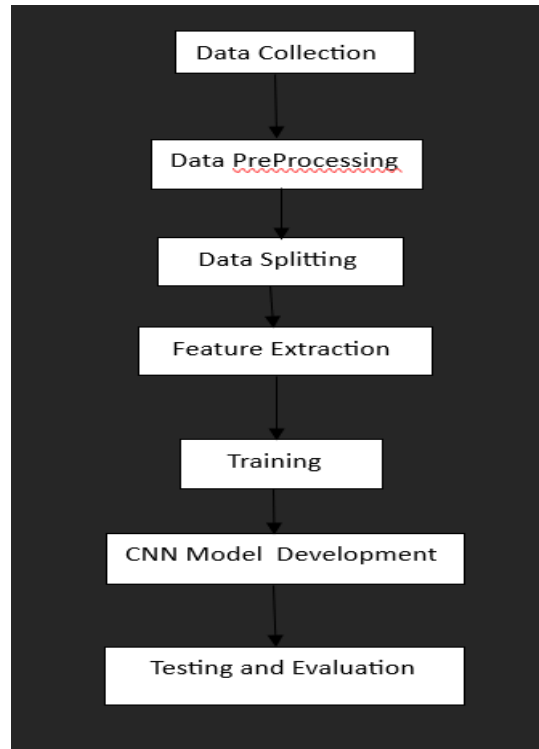


Fig 1: Flow chart

Dataset used:

The 3,297 photos of the ISIC's benign and malignant tumours dataset were used; these images were enhanced to provide more training data and balance the classes This dataset, which comes from Kaggle, well-known for its quality and diversity, making it suitable for creating strong skin-deep learning models cancer diagnosis.

Performance Evaluation metrics:

Accuracy: The model properly diagnosed 96% regarding the skin abnormalities within the in the test set, based on the major performance metric's remarkable 96% accuracy.

Precision and Recall: The model attained a recall of 90% and precision of 84% for the benign class, while for the malignant class, these values were 81% and 88%, respectively. The following formulas were used to determine these metrics:

$$\text{Precision (P)} = \frac{TP}{TP + FP}$$

$$\text{Recall (R)} = \frac{TP}{TP + FN}$$

F1-Score: The F1-scores were 87% for benign and 85% for malignant classes, providing a balanced measure of performance of the model throughout classes with unequal distribution [3].

$$\text{F1 Score} = 2 \cdot \frac{(P \cdot R)}{P + R}$$

IV. COMPARATIVE ANALYSIS TABLE

| Paper Title | Model Used | Dataset | Techniques | Accuracy | Strengths | Limitations |
|---|---------------------------|----------------|--|----------|---|--|
| A Comprehensive Analysis of Melanoma Cancer of the Skin Detection Using ML and DL | CNN, Hybrid ML-DL Models | Custom dataset | Optimization with ensemble methods | 94.5% | High accuracy, detailed feature extraction | Computationally intensive with large datasets |
| Early Skin Cancer Identification Using Deep Learning | AlexNet (pre-trained CNN) | ISIC 2018 | Transfer Learning, Data Augmentation | 98% | Robust with data augmentation, suitable for smaller datasets | Limited generalization without data balancing |
| Identification and Categorisation of Skin Cancer utilising Deep Learning | CNN (Custom Architecture) | 2018 ISIC | Data Augmentation, Hyperparameter Tuning | 96% | High precision, recall values, strong for binary classification | Limited scalability with complex multi-class lesions |

V. CONCLUSION

In conclusion, these studies collectively demonstrate the effectiveness of deep learning, deep learning, namely using neural networks that are convolutional (CNNs), in enhancing The precision and effectiveness of skin cancer detection. By leveraging methods like transfer learning, data augmentation, and hybrid model optimization, each approach addresses key challenges in medical image classification, including data scarcity, class imbalance, and computational demands. The models, especially those pre-trained like AlexNet, show high performance on datasets like ISIC 2018, achieving accuracy rates around 96-98%. However, limitations remain, such as model generalizability across diverse skin types and lesion complexities, implying that further studies could focus on improving robustness and scalability. These advancements in the field of deep learning offer promising support for early melanoma detection, clearing the path for additional reliable and accessible diagnostic tools in clinical settings.

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