© November 2024 | IJIRT | Volume 11 Issue 6 | ISSN: 2349-6002

A Comparative Study of CNN Architectures for Multi-Label Skin Cancer Classification

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Abstract: Skin cancer remains one of the most prevalent and life-threatening diseases, exacerbated by a general lack of awareness regarding its signs and preventive measures. As the global burden of skin cancer continues to rise, early detection is crucial for reducing mortality rates. This paper presents a novel approach for the detection and classification of multi-label skin cancer using Convolutional Neural Networks (CNNs) and advanced image processing techniques. We preprocess the HAM10000 dataset to eliminate irrelevant features and standardize input data, enhancing the model's performance. A comprehensive experimental analysis was conducted on the HAM10000 dataset, which encompasses seven distinct types of skin cancer. The results demonstrate that our CNN-based model outperforms traditional machine learning classifiers such as SVM, Decision Trees (DT), and Gaussian Naive Bayes (GNB), achieving superior accuracy in multi-label classification tasks. This work underscores the potential of deep learning techniques in the early diagnosis of skin cancer, paving the way for more effective clinical interventions.

Keywords- Skin cancer, Convolutional Neural Networks, Classification, HAM10000, Multi-label classification

I. INTRODUCTION

Skin cancer is a prevalent disease that poses significant health challenges across the globe, affecting humans, animals, and even flora. As one of the leading causes of cancer-related deaths, skin cancer is particularly concerning, with a notable impact on populations of all ages, especially children and the elderly. This disease manifests in various forms, including melanoma, basal cell carcinoma, and squamous cell carcinoma, with melanoma being the most unpredictable and aggressive type. It arises when skin cells mutate into malignant cells due to factors such as excessive exposure to ultraviolet (UV) radiation from the sun.

The rising prevalence of skin cancer highlights the critical need for effective detection and intervention strategies. Early diagnosis is crucial, as it allows for timely treatment options, including surgical interventions. Despite the serious nature of this disease, awareness of its signs and preventive measures remains limited among the general population. In the United States alone, millions of new cases of non-melanoma skin cancers (NMSC) and over 63,000 new melanoma cases were diagnosed in 2012, highlighting the critical need for improved detection methods.

Recent advancements in AI and ML have transformed the field of medical diagnostics. Notably, Convolutional Neural Networks (CNNs) have demonstrated exceptional potential in image classification, positioning them as a powerful tool for detecting skin cancer. Utilizing CNN algorithms can significantly improve the precision and efficiency of multi-label skin cancer classification. This approach not only aids in identifying various skin cancer types but also contributes to the broader goal of improving patient outcomes through early detection and intervention.

In this paper, we focus on utilizing CNN techniques for the classification of multi-label skin cancer, aiming to provide a robust framework for detecting and diagnosing this critical disease.

II. METHODOLOGY

A. Dataset Analysis

The ISIC 2019 dataset comprises 25,331 dermoscopic images designed for training purposes in the classification of skin lesions into nine diagnostic categories. This dataset also includes images from earlier ISIC challenges held in 2017 and 2018. The diagnostic categories are as follows:

- Melanoma
- Melanocytic nevus
- Basal cell carcinoma
- Actinic keratosis

- Benign keratosis (e.g., solar lentigo, seborrheic keratosis, or lichen planus-like keratosis)
- Dermatofibroma
- Vascular lesion
- Squamous cell carcinoma

Proposed Method

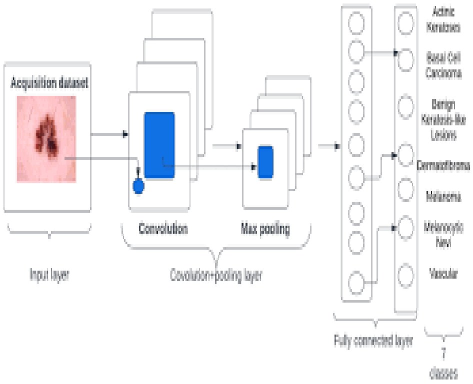

FIG 1: CNN ARCHITECTURE

CNN are advanced deep learning architectures tailored for analyzing grid-structured data, with a primary focus on image processing. Their architecture includes convolutional layers that apply filters to capture local patterns and features, activation functions like ReLU to introduce non-linearity, pooling layers to reduce spatial dimensions and prevent overfitting, and fully connected layers that integrate features for classification. The output layer typically uses a SoftMax function for multi-class tasks. By effectively learning spatial hierarchies, CNNs excel in image classification, object detection, and other computer vision applications, making them essential in various fields, including healthcare and autonomous systems.

III. OUTPUTS SCREENSHOTS

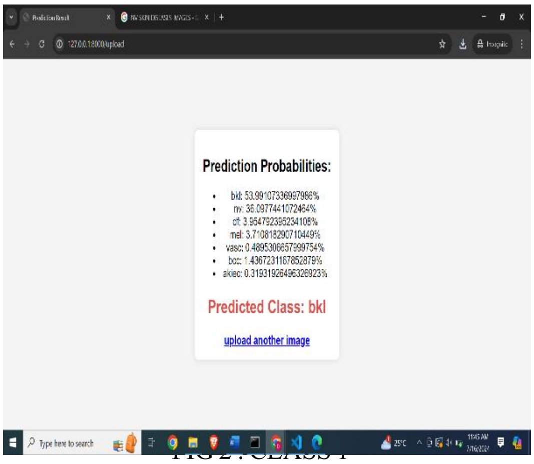

FIG 2 : CLASS 1

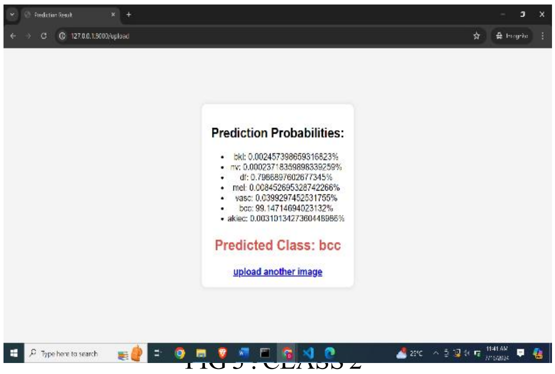

FIG 3 : CLASS 2

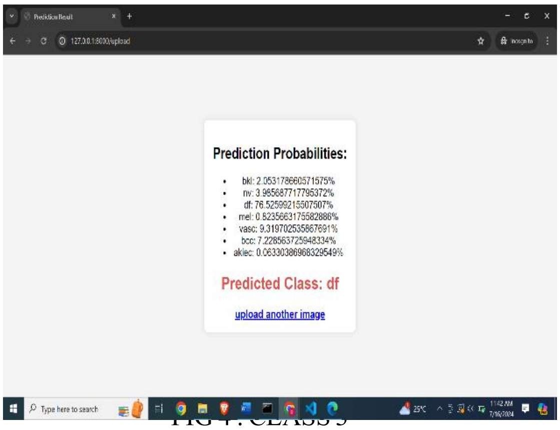

FIG 4 : CLASS 3

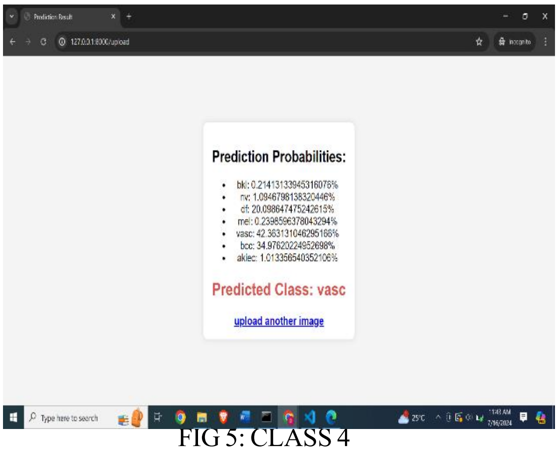

FIG 5: CLASS 4

IV. DISCUSSION

The classification of skin lesions encompasses various types, including Basal Cell Carcinoma (BCC) (Figure 2), the most prevalent form of skin cancer. It typically presents as a pearly nodule or a flat patch on areas frequently exposed to the sun and is characterized by slow progression and a high success rate of treatment if identified early. Dermatofibroma (Figure 3), often referred to as moles, are non-cancerous clusters of pigment-producing cells, but changes in their appearance may signal malignancy. Vascular Lesions (Figure 4) exhibit a wide range of presentations, from harmless haemangiomas to potentially severe conditions, often distinguished by their reddish or purplish hue. Lastly, Benign Keratosis (Figure 5) encompasses solar lentigines (commonly called sunspots), seborrheic keratosis (wart-like raised growths), and lichen planus-like keratosis (flat-topped lesions). Although these are typically benign, they can sometimes be mistaken for malignant growths, highlighting the critical need for accurate identification and diagnosis.

V CONCLUSION

Skin cancer remains a significant global health issue, with approximately 5.4 million new melanoma cases diagnosed annually in the United States. This study highlights the effectiveness of utilizing Convolutional Neural Networks (CNNs) for classifying different types of skin cancer using the HAM10000 dataset, achieving an impressive accuracy of 93%. This strong performance demonstrates the potential of deep learning methods to enhance early detection and treatment strategies for skin cancer. Moving forward, we aim to further optimize the CNN model and explore additional classification techniques to improve outcomes in medical diagnostics.

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