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# Skin Lesion Diagnosis Using Deep Neural Networks

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**Abstract**

Skin cancer is one of the most common cancers in the world. Early detection of cancerous lesions is of great importance in treatment. Skin lesion images contain important information for classification, and due to the diversity of lesion shapes, automated image processing systems effectively help in diagnosing the type of lesion. Due to the appropriate accuracy of artificial intelligence, especially deep learning methods in image classification, their use in medical image classification is also expanding. Despite their appropriate accuracy, these models have a large computational burden that limits their use. The use of lighter deep learning algorithms increases the hope of using them as applications on mobile phones in society.

In this study, an efficient model for classifying skin lesions has been proposed to help diagnose the disease. In this model, four convolutional layers, two merging layers, and two batch normalization layers were used. This model helps to identify the correct class of input samples by structurally examining similarities and has been tested on images of a wide range of skin cancer types from different individuals. The skin lesions in this set are distributed in seven main classes. Using the technique of increasing the number of samples, we correct the imbalance of the dataset used. In classifying the data set by the presented model, the accuracy and precision of the proposed method were 87.72% and 89.1%, which due to the number of parameters and smaller volume, the proposed method has improved compared to the group learning methods, simple convolutional network, and transfer learning.

**Keywords:** Convolution, Deep learning, Melanoma, Skin cancer, Segmentation.

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**Introduction**

Cancers account for 9% of all deaths and are the second leading cause of death in the world. Skin cancer is the most common human cancer in the world. Millions of skin cancer cases are registered worldwide each year. Melanoma is one of the most dangerous types of skin cancer, accounting for 4% of all cancers in men and 3% of all cancers in women. Melanoma can also be considered the most dangerous form of skin disease, accounting for the largest proportion of deaths related to skin lesions(Mastrolonardo, Conte and Zbilut). If these cancer cells can be detected at an early stage, the chances of saving people's lives increase significantly(Korotkov and Garcia). Therefore, accurately distinguishing between melanoma and other pigmented skin lesions (non-melanoma) is a serious challenge for dermatologists(Goyal et al.; Kassem et al.). The most common diagnostic method that doctors use to diagnose various skin lesions is the ABCD technique. By measuring four morphological features, skin lesions can be divided into melanoma, malignant, and non-melanoma categories(Okabe et al.; Wang et al.). Asymmetry, border irregularity, color distribution, and lesion diameter are among the features that constitute this method. Diagnosing skin cancer by non-invasive experimental methods is a challenging task even for dermatologists due to the varying appearance of skin lesions(Khodadadi et al.).

On the other hand, the use of computer systems for CAD diagnosis in the diagnosis of skin lesions is also a growing area of research that has generated great interest in the development of recognition systems through machine learning and deep learning methods(Araújo et al.). Early detection of cancerous lesions plays an important role in their treatment, so the classification of skin lesions is very important. The image of a skin lesion contains important information for the classification of the lesion, which is used with digital image processing and classification methods. Given the shortage of dermatologists and the diversity of lesion shapes, the use of automated processing systems can effectively help the patient and the specialist to diagnose the type of lesion. The prevalence of this diagnostic aid tool in society helps to improve public health and hygiene in society. Smartphones are the most suitable of these computers, which have spread significantly in society and have good processing capabilities. Today, deep learning methods have shown good accuracy for classifying various images, so their use to help diagnose and classify medical images is also expanding. Despite their good accuracy, these models also have a high computational load, which limits their use in mobile phones with relatively moderate processing capabilities. Therefore, the use of lighter deep learning algorithms increases the hope of using them as applications on mobile phones of individuals in society. Skin cancer complications can be divided into two main groups: melanoma and non-melanoma. Melanoma is considered the most dangerous type of skin cancer. This research aims to design an automatic system for diagnosing melanoma skin lesions. The designed system consists of four main parts: preprocessing, segmentation, feature extraction, and classification.

Although artificial intelligence methods have been widely used in the diagnosis of melanoma skin disease, very few methods have used deep learning to diagnose melanoma skin disease. In this study, we intend to use deep neural networks to diagnose malignant melanoma. In the proposed method, we use convolutional neural networks to diagnose skin disease. Convolutional neural networks have two main stages: first, feature extraction is performed in the initial convolutional layers, and finally, the classification operation is performed in the final layers.

**Background**

The research work of Dorj et al. is one of the first works that has tried to present a fast and intelligent method for classifying skin cancer with a deep convolutional neural network(Dorj et al.).
In their research, Nawaz et al. present a fully automated method for segmenting skin melanoma at its earliest stage using a deep learning approach, namely, region-based convolutional neural networks (RCCN) combined with fuzzy k-means clustering (FKM) for segmentation(Nawaz et al.). Ghahfarokhi et al. have presented a computer-aided diagnosis (CAD) system based on machine learning algorithms for classifying different types of skin cancer(Ghahfarrokhi et al.). Researchers have used pre-trained models such as ResNet50 and EfficientNet to improve the accuracy of diagnosing melanoma and other skin lesions, and have succeeded in achieving an accuracy of more than 90% in diagnosing melanoma(Zhang et al.). Another study in 2023 investigated the segmentation of skin lesion images using U-Net models and showed that using this method can lead to more accurate lesion identification and improved results in final diagnosis(Liu et al.). In another study, the CNN model, by combining image preprocessing techniques and using very large data sets of skin lesion images, was able to perform better than traditional disease diagnosis methods(Baig et al.).

**Methodology**

In the proposed method, an attempt is made to achieve good accuracy for skin disease diagnosis by changing the structure of the default layers of the convolutional neural network and also by preprocessing unbalanced data.
The steps are:
1. Image preprocessing: Image size matching, data size balancing are among the possible tasks in data preprocessing.
2. Feature extraction using a convolution layer: To generate feature vectors, convolution kernels are applied to the input data regions, and feature vectors are extracted.
3. Model building using deep neural network: Model building using a convolutional neural network is similar to model building using a deep neural network, but with a few differences. Convolutional neural networks (CNN) are specifically designed for processing image data. They use convolutional filters to extract local features from images.
4. Model evaluation: After building the model, the model is evaluated using precision, accuracy, and recall criteria.
The convolutional neural network in this study consists of four convolutional layers, two pooling layers, and one fully connected layer.
The proposed method in this study is implemented on dermoscopic images consisting of skin lesion images based on the HAM10000 dataset. This dataset contains a set of images representing all important diagnostic categories in the domain of pigmented lesions.

**Findings**

In this study, the data were used for testing. The 5-way cross-validation method was used to evaluate the results. The main diameter of the confusion matrix, which shows correct predictions, has correctly identified an acceptable number of cases for most classes and has misdiagnosed a few cases, which means that the proposed model has a good ability to diagnose skin diseases. The proposed method has been able to have an appropriate accuracy, sensitivity, and criterion for distinguishing each class. As it is clear, the accuracy and sensitivity in most classes for the training data are above 97%. The accuracy obtained in the first iterations is very low, and as the network is

further trained and repeated, the accuracy of training and validation for the proposed method increases until the accuracy of the proposed method reaches a stability. The proposed method has an accuracy of 89.1% and an accuracy of 87.72% on the experimental dataset, which is a comparable result to the previously mentioned methods.

**Conclusion**

In this study, dermatoscopic images from the HAM10000 dataset, which have been collected and stored from various disorders, are used. This dataset, with more than 10015 training images, is used to detect pigmented skin lesions. By applying the proposed method to the aforementioned dataset, we achieved accuracy, precision, and recall of 87.72%, 80.1%, and 90.4%, respectively, in the test data, which is very good accuracy compared to previous works in this study. By examining the effect of layers and the connection weights between them, we can reduce the network size and computational load by eliminating small values.

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