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Dermatitis Atopic and Psoriasis Skin Disease Classification by using Convolutional Neural Network

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ABSTRACT

Skin is the one of the body parts that play a large role in human physical body. There are so many functions of the skin such as offering protection against fungal infection, bacteria, allergy, viruses and controls the temperature of the body. But, the reported shown that the skin disease is the most common disease in humans among all age groups and a significant root of infection. The diagnosis of skin diseases involves several tests. Due to this, the diagnosis process is seen to be intensely laborious, time-consuming and requires an extensive understanding aspecially for the skin disease that have similar symptoms. Two skin diseases that have similar symptoms and most misdiagnosed are atopic dermatitis and psoriasis. Convolutional Neural Network for image processing and classifying have been developed for more accurate classification of skin diseases with different architectures. However, the accuracy in determining skin lesions using CNNs is on the average level. The factors that affect the accuracy result of a CNN is the depth where gradients vanished as the network goes deeper. Another factor is the variance in the training set which means the need of the large size of training set. Hence, in this study we tried 10 CNN architecture to get the best result for classifying dermatitis atopic and psoriasis. These are VGG 16, VGG 19, ResNet 50, ResNet 101, MobileNet, MobileNet V2, DenseNet 121, DenseNet 201, Inception and Xception. Experimental result shown that the inception V3 architecture give the best result with accuracy for data testing 84%, accuracy for unseen data 82% and confusion matrix with True positive obtained is 248, True Negative is 61, False positive is 54 and False Negative 298.

Keywords: Skin Disease, Dermatitis Atopik, Psoriasis, Classification, Convolutional Neural Network, Inception V3.

1. INTRODUCTION

One of the body parts that play a large role in human physical appearance are skins. Skin is also the largest organ of the human body which has weight between six and nine pounds and a surface area ~~of~~ about two square meters. There are so many functions of the skin such as offering protection against fungal infection, bacteria, allergy, viruses and controls the temperature of the body. The situations that change the texture of the skin calls skin disease. Skin disease can produce symptoms like swelling, burning, redness, and itching [1].

Skin disease is one of the most common types of health diseases faced by humans for centuries[2]. The skin diseases found in humans, some of which are simple and

easily treatable, but others are very dangerous and may not be curable[3]. The diagnosis of skin diseases largely depends on the expertise of the doctor and the results of a skin biopsy, which is a time-consuming process [2]. The diagnosis of skin disease will be more complicated when two or more diseases describe the same or similar symptoms [3]. Two skin diseases that have similar symptoms and most misdiagnosed are atopic dermatitis and psoriasis.

Atopic dermatitis and psoriasis are chronic inflammatory skin diseases with almost the same aspects, including similarities in characteristics, physical appearance, and symptoms [4]. The similarity in several aspects of Atopic Dermatitis and Psoriasis are the causes frequent misunderstandings in both of them. Therefore, an accurate analysis of atopic dermatitis and psoriasis is needed so as to improve diagnosis, speed up diagnostic time and lead to better and cost-effective treatment for patients [2].

Previous studies have been successfully achieved in classifying skin diseases through image processing techniques and different algorithms. The image processing techniques have been use are Support Vector Machine [5], Gray-Level Occurrence Matrix [7], Artificial Neural Network [8] and many more. However, current studies and researches about Convolutional Neural Network for image processing and classifying have been developed for more accurate classification of skin diseases with different architectures [9]. Related works have been developed using the convolutional neural network by using AlexNet architecture [10] that studied by Liao et. al. that reaches mAP score or 0.70 for classifying multiple class skin disease [11]. An existing study has also used CNN for classification of six common skin diseases using the architecture of nested residual or ResNet structure that got 65.8% accuracy. The previous reasearch has been compared four different architectures such as VGG-16, Google Net, ResNet-50 and ResNext-50 [11] to their method which achieves better performance for psoriasis, eczema, nevus and basal carcinoma class accuracy. Zhou et al, also achieved better performance for eczema and psoriasis. The accuracy of that two skin disease are 75.3% and 55.2% [12].

The previous researches has been proven the capability for detection of skin disease using different kinds of CNN model and architecture [13]. However, the accuracy in determining skin lesions using CNNs is on the average level [14]. The factors that affect the accuracy result of a CNN is the depth where gradients vanished as the network goes deeper [15]. Another factor is the variance in the training set which means the need of the large size of training set [16]. Developing a better system that would improve the accuracy in determining skin lesions could help better identify skin diseases, especially between atopic dermatitis and psoriasis which has the most similarity in features [17].

The objective of this research is to classify the dermatitis atopic and psoriasis skin disease through convolutional neural network and verify the accuracy of the system in determining the skin disease of a patient using a confusion matrix, accuracy, precision, recall, F1 score, accuracy testing and confusion matrix by using unseen data. The significance of this research is in classifying the correct skin disease, so it's can treated immediately and right prescription. The right prescription and treated immediately can prevent the cause of bacterial infection. Furthermore, this study can benefit on the global aspect that could help future researchers improve the diagnosis of skin diseases.

This study and research focuses on classifying the skin diseases such as atopic dermatitis and psoriasis chronic plaque using some of architecture of the CNN

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(VGG 16, VGG 19, ResNet 50, ResNet 101, MobileNet, MobileNet V2, DenseNet 121, DenseNet 201, Inception and Xception) then evaluate the architecture that can produce the best results for large dataset. Only two types of skin diseases which are dermatitis atopic and psoriasis will be classified. The probability in which has the highest score will be the system's classification Based on the proposed model, the study will not cover identifying other skin diseases. The accuracy of the system will be confirmed using the statistical treatment, confusion matrix.

This paper is organized as follows. In section 1 of this paper discusses the introduction of the contents of the paper, Part 2, introduces the proposed method. Section 3, describes the CNN model as a whole. Section 4, describes the performance evaluation by comparing the architecture in binary classification. Finally, section 5 shows the conclusions of this work.

2. MATERIAL AND METHOD

2.1 DATA PREPARATION

This dataset is obtained from the from DermIs, DermNet, and DermatoWeb as the dataset [6]. The dataset contains Dermatitis atopic and psoriasis skin disease images. The total of dataset are 2.640 images for traning set, 661 images for testing set and 75 images for unseen data. The image resolution that will be used in this study is 224 X 224. This resolution is used because the default input image size on the Inception V3archtecture is 224 X 224.

FIGURE 1. Sample Dataset

2.2 DATA PREPROCESSING

In this process, the data augmentation stage is used to increase the amount of data without losing the essence of the data. In this research, data augmentation include

rotation, flipping, zoom and shear. Augmentation of the data is automatically using an image data generator that will convert data from raw images into augmented images. From the augmented data, 1,569 cases of atopic dermatitis and 1,807 psoriasis cases were generated. After applying all the transformations, each image is normalized. After adding to our dataset, we get 3.376 images. Then we divided it into training and test set. In training process, 2.640 images (80% of total dataset) was used for model learning. We save 661 images (20% of the whole dataset) for testing model. We also prepared 75 images as unseen data. Table 1 shows the transformations that applied to the Data Augmentation Process.

TABLE 1.
Transformations that applied to the Data Augmentation Process

Transformasi	Probabilitas
Rotation	20^0
Random Zoom	0.2
Shear	0.2
Vertical Flip	0.5
Horizontal Flip	0.5
Horizontal Shift	0.2
Vertical Shift	0.2

2.3 CONVOLUTIONAL NEURAL NETWORK

The Convolutional Neural Networks are deep artificial neural networks used primarily for classifying images. CNN cluster images by similarity and perform object recognition within scenes. CNN is applied in identifying faces, individuals, street signs, tumours, platypuses, and many other aspects of visual data [25,26]. Convolutional neural networks are composed of multiple layers to process and learn the representation of the abstract levels of a data[11]. CNN composed of multiple processing layers to learn representations of data with multiple levels of abstraction [12], have achieved remarkable breakthroughs in respect of many tasks such as image classification and detection. CNN algorithm proposed in [27] was adopted for the current study. Fig. 3 shows the operational steps of CNN. The CNN reduces the input image into a form which easier to process. The first convolutional layer (CL) then moves to the maxpooling layer (PL) stage second convolutional stage until the fully connected neural network is obtained.

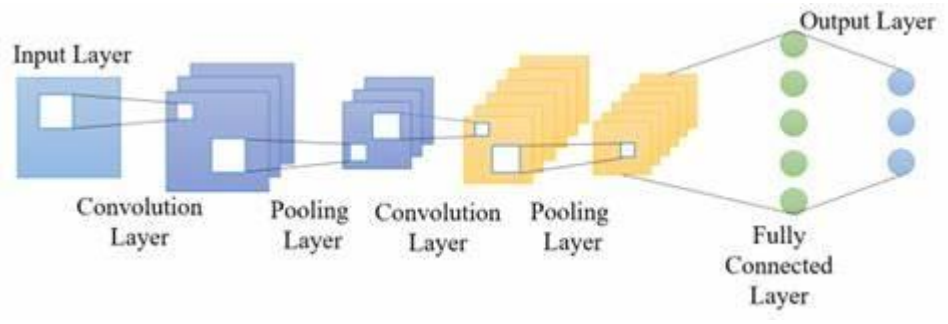

FIGURE 2. CNN architecture

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The classification of atopic dermatitis and psoriasis in this study was using CNN classification with transfer learning techniques through the 10 architectures of CNN, there are VGG 16, VGG 19, ResNet 50, ResNet 101, MobileNet, MobileNet V2, DenseNet 121, DenseNet 201, Inception and Xception architecture.

2.4 VALIDATION

Measuring the performance of a classification system is important. The performance of the classification system describes how well the system is in classify data. Confusion matrix is one method that can used to measure the performance of a classification method. Basically confusion matrix contains information that compares classification results carried out by the system with the results of the classification that should be [7]. In measuring performance using confusion matrix, there are 4 (four) terms as a representation of the results of the classification process. The four terms are True Positive (TP), True Negative (TN), False Positive (FP) and False Negative (FN). True Negative value (TN) is the amount of negative data detected with true, while False Positive (FP) is negative data but detected as positive data. Meanwhile, True Positive (TP) is positive data detected correctly. False Negative (FN) is the opposite of True Positive, so the data is positive, but it is detected as negative data. In the type of binary classification that only has 2 class output, confusion matrix can be presented as in Table II [8].

TABLE 2.
Confusion Matrix

Class	Positive Classified	Negatif Classified
Positive	TP (True Positive)	FN (False Negative)
Negative	FP (False Positive)	TN (True Negative)

Based on the value of True Negative (TN), False Positive (FP), False Negative (FN), and True Positive (TP) can be obtained values of accuracy, precision and recall. Value accuracy describes how accurately the system can classify data correctly. In other words, the value of accuracy is a comparison between data correctly classified with all data. Accuracy values can be obtained by Equation Accuracy = (TP + TN) / (TP + TN + FP + FN)) * 100%. Precision value describe the number of positive category data that are correctly classified divided by the total data classified as positive. Precision can be obtained by The ecision equation = (TP / (TP + FP)) * 100%. Meanwhile, the recall shows what percentage of positive category data is correctly classified by the system. The recall value is obtained by the Recall Equation = (TP / (TP + FN)) * 100%.

3. METHODOLOGY RESEARCH

3.2 CNN ARCHITECTURE

Convolutional neural networks are composed of multiple layers to process and learn the representation of the abstract levels of a data. In this study, 10 architecture are implemented and compared to see which architecture that can produce the best results for large dataset.

The architecture that implemented in this are VGG 16, VGG 19, ResNet 50, ResNet 101, MobileNet, MobileNet V2, DenseNet 121, DenseNet 201, Inception and Xception. Then, after that the result in each architercture will be compared to see the best architecture for dermatitis atopic and psoriasis classification.

4. RESULT & DISCUSSION

4.1 RESULT

Table 3 shown the result for each architectures that implemented for dermatitis atopic and psoriasis classification.

TABLE 3.
The Result Dermatitis Atopic and Psoriasis Classification for Each Class

Models	Accuracy for Data Testing	Accuracy for Data Unseen	Precision	Recall
VGG16	0.78	0.60	0.86	0.64
ResNet50	0.82	0.77	0.86	0.73
MobileNet	0.84	0.81	0.82	0.73
DenseNet121	0.81	0.71	0.78	0.82
Xception	0.82	0.72	0.84	0.78
VGG19	0.78	0.69	0.80	0.71
ResNet101	0.84	0.79	0.87	0.78
MobileNet V2	0.81	0.68	0.81	0.78
DenseNet201	0.82	0.75	0.86	0.74
Inception V3	0.84	0.82	0.82	0.80

The performance comparison among the CNN architecture was made by using accuracy for data testing and unseen, precision and recall. It shows that Inception V3 give the better result than others. Initially after 50 epoch, the accuracy for data testing, accuracy for data unseen, precision and recall were 0.84, 0.82, 0.82 and 0.80. The following graph shows the accuracy of training and testing like that shown in figure 3 below.

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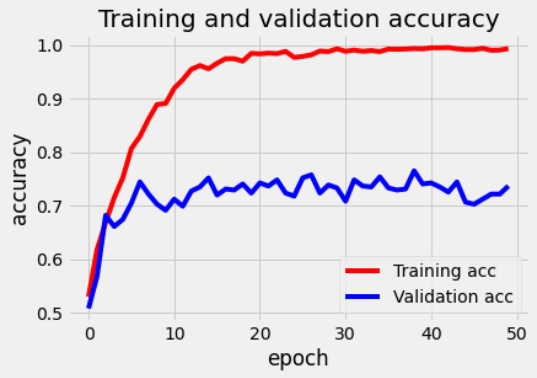

FIGURE 3. Training and testing accuracy curve

While the cross entropy loss shown in figure 4 below.

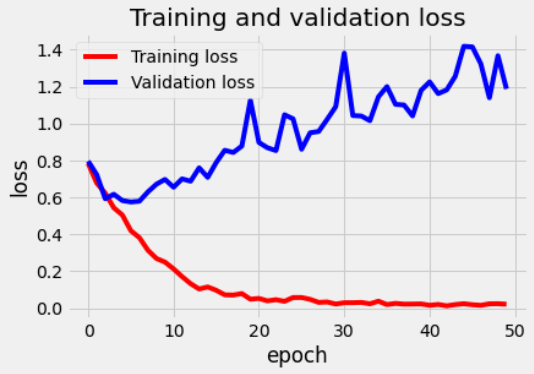

FIGURE 4. Cross entropy loss value

The results of the confusion matric calculation are based on experiments in the jupyter notebook show good results, as shown in figure 5.

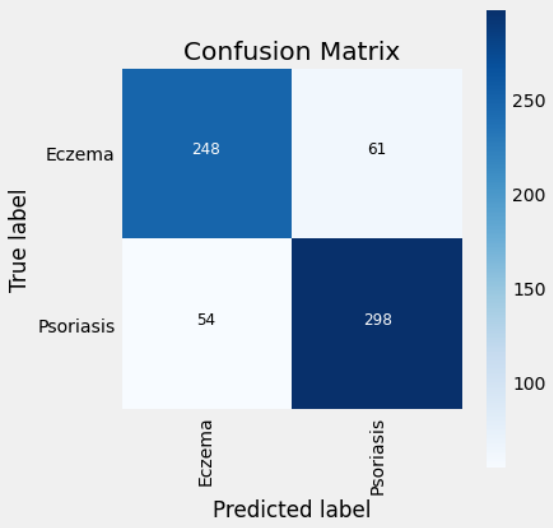

FIGURE 5. Confusion Matrix for Testing

Based on the figure above shows that the positive True obtained is 248, True Negative is 61, False positive is 54 and False Negative 298. Value the precision obtained is 0.82 while for the recall value is 0.80.

The result of classification process of Dermatitis Atopic and Psoriasis skin disease by using unseen data, also gives best results at an accuracy rate of 82%. The results of the confusion matrix calculation are based on experiments in the jupyter notebook show good results, as shown in figure 6.

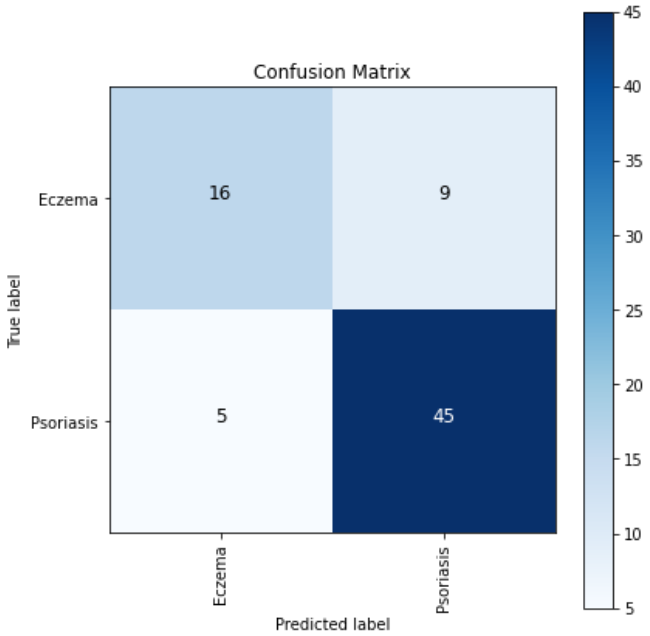

FIGURE 6. Confusion Matrix for Classification Unseen Data

The figure above shows that from the 75 images, the Positive True obtained is 16, True Negative is 9, False positive is 5 and False Negative 45.

4.2 DISCUSSION

Based on the results of research conducted by the author shown a classification approach to Dermatitis atopic and Psoriasis classification. Here we compared CNN architecture, those are VGG 16, VGG 19, ResNet 50, ResNet 101, MobileNet, MobileNet V2, DenseNet 121, DenseNet 201, Inception and Exception. After using these architectures, we have seen that the best result was found from Inception V3. There was overfitting, so the preprocessing or detection stage needs to be done before the stage training, testing and classification of data is carried out. The accuracy and confusion for classifying dermatitis atopic and psoriasis is 84% and confusion matrix with True positive obtained is 248, True Negative is 61, False positive is 54 and False Negative 298.

5. CONCLUSION

In this paper, classifying the Atopic Dermatitis and Psoriasis is proposed using the algorithm of CNN Inception V3 architecture to diagnose the skin disease on the

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following body parts. The study has built a large dermatology dataset from the popular dermatology atlas for the training and testing set. Based from the results, the method of CNN Inception V3 architecture has achieved high performance on classifying the atopic dermatitis and psoriasis chronic plaque yielding an accuracy rate of 84%. The model has also successfully classify dermatitis atopic and psoriasis skin disease for unseen data.

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