Skin Disease Detection for Kids at School Using Deep Learning Techniques

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Abstract—Due to the rapid spread of skin diseases among children in school, and the fact that skin disease is the most common contagious disease spreading within students in school, this study investigates the factors that could help in early detection of these skin diseases using AI techniques. The texture and color of the skin can change as a result of the disease. Examples of these diseases are chickenpox, impetigo, scabies, infectious erythema, skin warts, and other infectious skin diseases. Skin disorders are long-term and contagious, it can be detected early and with high accuracy before it become a long-term problem. This research builds a system of skin disease detection using the CNN technique and a pre-trained VGG19 model. In addition, the dataset contains 4500 images that were collected from different sources to train the VGG19 model. Data augmentation technique such as zooming, cropping, and rotating were used. After that, the Adamax optimizer, which is most suitable for the proposed methodology, was used to obtain high accuracy and required results. This study achieved a high accuracy of 99% compared to other similar researchs. It can be concluded that this system is very reliable which can be integrated to smart schools as part of IOT systems.

Keywords—skin diseases, detection, kids, VGG19, CNN

1 Introduction

The skin is a very sensitive area, and it must be taken care of. A person may become ill as a result of contact with another person who is infected, or through contact with patients who feel symptoms of the disease such as heat, sneezing, and others. There are many infectious skin disease, this research concerned with infectious skin diseases that are spread among children.

Artificial intelligence technologies represent a very important and large part of the world today. They are used in most areas. The health field is an example of this. In this research, infectious skin diseases that affect children are discussed and detected using deep learning techniques, especially CNN technology, which has achieved high accuracy rates in many previous studies.

1.1 Conventional Neural Network CNN

Deep learning DL is a subset of machine learning and is an area of artificial intelligence (AI) that mimics the work of the human mind in data processing. Deep learning is often referred to as hierarchical learning or deep organized learning [1]. Artificial Neural Networks ANN are algorithms that are inspired by brain structure and function ANN. In a neural network, the" deep" portion is usually made up of many hidden layers. A deep neural network has more than 3 layers, up to 150 layers, whereas a conventional neural network CNN has just 2-3 hidden layers. Wide sets of classified data and neural network architectures that learn features directly from the data without the need for manual extraction are used to train deep learning models [2]. Figure 1 shows, the basic structure of CNN, which is a type of deep learning [3].

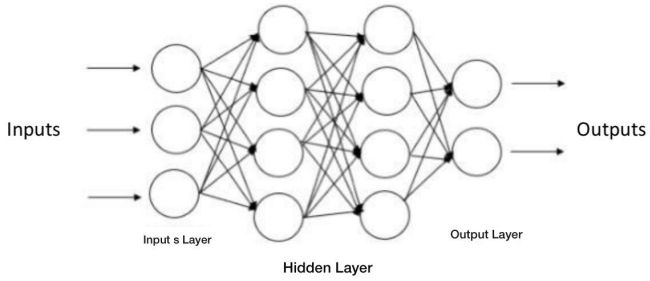

Fig. 1. The basic structure of CNN

This study, will use CNN techniques that are compatible with dataset. For it is advantage of extracting images with high accuracy.

The importance of this study is to try to help improve the school's health care system. Hence, this study helps schools in the rapid detection of infectious skin diseases and the speed of decision-making about the infected child before the development of his condition and before the spread of infection among colleagues. Furthermore, it helps in making the educational environment healthy and suitable for children without fear of diseases.

2 Related work

Skin diseases and AI have been discussed in many areas in the field of health systems, which has been related and useful for this study. For example, There are studies which discussed common skin diseases and improved accuracy, each discussion used different techniques and methods and ending with different results and performance. As in mentioned in the study [4], it organized two different competitions to compare the performance of DNN frameworks with the performance of general practitioners by observing the image without assistance. It developed information to maximize the obstetric adversarial network (infoGAN) to generate synthetic skin images. It was proven that DNN has an effective performance for classifiers of skin lesions and can improve the accuracy of non-specialist clinician performance. While In

the study [5], Patient data were processed using KNN and ANN techniques. In order to understand and identify the types of skin diseases, ANN technology used a sequence of 6 steps. It began by inserting and reading a picture of a skin disease and ended with a decision on the type of disease. It was concluded from the study that a cost- effective, easier and faster result was provided in detecting the diagnosis of the skin under the supervised skin area.

On the other hand, several authors discussed skin cancer and early detection methods with different techniques and algorithms. The results were varied and interested as in [6], which used fluoroscopy images and 4 different machine learning methods ANN, SVM, KNN and DT. Artificial Neural Networks (ANN), Support Vector Ma- chine SVM, K- Nearest Neighbors (KNN), and DT were compared with each other within the PH2 data set. The study showed that ANN had the best classification performance for the PH2 data set 90.50% and was more successful at Classification of cutaneous lesions, while the rest were respectively, DT of 90,00%, KNN of 82,00%, SVM of 89,50%. In addition [7], applied the (CAD) system and the images using the (CLA) filter. CLAHE technology was used to improve dermatoscopic images. Then, (NOS) was used to split the images. Supported by various ML algorithms such as ANN, ANFIS, SVM, DLNN, and HybridAdaBoost ,15 input features are extracted to improve the classification accuracy. It was concluded that DLNN and HypridAd- aBoost perform well compared to the other ML algorithms. The field of deep learning and detection of different kind of cancer (brain, breast and colon) have been widely used in the literature, not necessary the skin but using the scans or the images of the infected area of the body [8][9][10].

On the other hand [11], covered the liver disease diagnosis. It used KNN and SVM al- gorithms. It was evaluated based on four criteria: Accuracy, sensitivity, specificity and precision. The conclusion was clarified that SVM shows that it has more accuracy as well as KNN and through which the best algorithm giving better accuracy is defined as KNN.

There are some studies which made use of digital images. For example, in the study [12], the ability of DLS to assist practitioners in diagnosing skin diseases was highlighted. DLS consists of two main components: Variable number of deep convolutional neural network modules to handle a flexible number of input images and a shallow module for processing metadata such as history of demographic and medical information. DLS has been shown to have an effective role in the differential diagnosis of dermatological diseases and can improve the accuracy of general practitioners performance. In addition [13], discussed the three skin diseases (Melanoma, Eczema, Psoriasis). It takes a digital image of the area of the skin with a pathological effect, and then preprocessing it and then extracts the features using the techniques of the (CNN) previously trained (AlexNet) and SVM. The study successfully discovered 3 different types of diseases with 100% accuracy. While the study [14] discussed skin disease taking a digital image of the affected skin area. It used a computational technique to analyze, process and distribute the image data based on the different features of the images. Features are extracted using complex techniques such as (CNN), image classifier based on SoftMax classifier algorithm and obtain re-diagnosis as an output. In conclusion, the system can have more precision and produce quicker results.

The study [15] used techniques which are based on computer vision to detect skin diseases. It used several image processing algorithms and then fed to artificial neural network to train on data. There are two phases. First, pre- processing skin color to extract features. Second, detecting 9 types of akin diseases. Then, applying image processing algorithms on infected area images. Then, taking user input such as gender, age, duration, liquid type for training. It is difficult to analyze skin surface using image processing techniques, but the study acquired good sample from patients for training and the result of detection rate found to very successful in detecting 9 diseases.

The use of deep learning methods for skin disease diagnosis was discussed in [16]. It is difficult to get and use the data for training because rare skin diseases and similarities of skin diseases. In the study, skin disease recognition in images used convolution neural network in deep learning and CNN model for representation of skin features. The study showed very good performance of deep learning when compared to other traditional techniques such as such as histogram, statistics, color texture.

Finally, COVID-19 was investigated in [17]. the discovery of Covid-19 through X-rays was discussed. The study classified model and studied its accuracy on 8 different models (Deep CNN): AlexNet, VGG16, VGG19, DenseNet201, Xception, ResNet50, Sequential and InceptionV3. The performance measurement of the models is based on criteria such as accuracy, sensitivity, specificity, (FRR), F1-score, MCC and Kappa. It used the Vs all and CNN method as the structured argument. According to experimental results, The VGG16 model achieved the highest accuracy, which was 97.69%.

The Table 1 summarize the information about each research and study found on detecting skin diseases and other disease.

Table 1. A summary of related studies

Reference	Type disease	Year	Techniques	Dataset	Accuracy
[4]	Skin diseases	2020	DNN GAN	10015 Images	65-70%
[5]	Skin diseases	2016	KNN ANN	342 Images	_
[6]	Skin diseases	2017	KNN ANN SVM DT	PH2 200 analog Images	82.00% 92.50% 89.50% 90.00%
[7]	Melanoma Skin lesions	2016	SVM Hybrid support vector	992 Images	93%
[11]	Liver disease	2011	KNN SVM	Used BUPA from UCI Development set: 56,134 images Validation set A: 14,883 images Validation set B (subset of ”A”): 3,707 images	97% 97%
[12]	Skin diseases	2020	DLS	Dataset source from teledermatology practice serving 17 primary careand specialist sites from two states in the US	71% 93%

[13]	Skin diseases	2019	CNN SVM AlexNet	80 Images	100%
[14]	Skin diseases	2018	CNN	A group of images were taken, But their number was not mentioned 775	70%- 90%
[15]	Disease detection	2014	ANN IP	Images from Sir Salimullah Medical College and Mitford Hospital, Dhaka Bangladesh	90% 97% 91% 85%-88%
[16]	Skin Diseases Review	2020	CNN	DermIS DermQuest DermNZ and Dermnet dataset 90% and ISIC competition dataset	70% 80%-89% 99.5% 97.5%
[17]	Skin diseases	2020	CNN Vs all VGG16	6106 Images	VGG16 =97.69%

3 The methodology

The technique that will be applied is CNN, after the long analysis in the literature. The proposed methodology for this study will be explain in details in the following sections.

3.1 Data collection

Data have been gathered by collecting images from various libraries for skin diseases. The database contains 4500 of all the selected diseases (Chickenpox images, Impetigo images, infectious erythema, scabies images, Skin warts images). The dataset for this project was collected from these libraries [18][19][20]. These data consist of five infectious skin diseases common among school children:

Chicken pox. The varicella-zoster virus causes a skin infection that affects the skin and mucous membranes" conjunctiva and soles of the mouth," causing extreme itching and the appearance of red spots or blisters all over the body. Figure 2 [18] shows the chickenpox photos. It normally affects children between the ages of 5 and 9.

Fig. 2. chickenpox, with different scales and different lighting conditions

Impetigo. It is a highly infectious disease that most commonly affects children between the ages of two and five years. It is a red sore that can be filled with pus or blisters caused by bacteria, and it has the potential to spread and cause tiny black spots and yellow to brown crust, and these sores spread across the body but are often concentrated around the mouth and nose [18]. Figure 3 shows the impetigo pictures. Since impetigo is highly contagious, an accurate diagnosis is needed to prevent the spread of impetigo among children [21].

Fig. 3. Impetigo forms

Infectious erythema. Children's disease, also known as the "fifth disease," is an infectious disease that affects the child as shown in Figure 4, illustrations by children's [18][119]. This diseases is characterized by a rash and mild fever and is caused by infection with the parvovirus(B19), and is more common in late winter and early spring, this virus spreads among people through nasal secretions or sneezing, and among the most prominent signs of the disease: the rash may appear on the face after an incubation period that lasted for several days, the rash lasts from 10 to 14 days and then begins to disappear gradually, in addition to a high Temperature,sore throat and nasal congestion [22].

Fig. 4. Some pictures of the infectious erythema

Scabies. This disease is caused by parasites that live on human skin and infect it with bacteria. This disease is caused by the Sarcoptes scabiei mite, which can be transmitted by skin-to- skin contact between adults and children. Children under the age of two are most often affected. Every year, it is estimated that 300 million people are infected around the world. The disease causes extreme itchiness and rashes on the skin. Scabies photos can be found in Figure 5 [19][23].

Fig. 5. Images of scabies in children

Warts skin. Skin warts are caused by an infection in the epidermis, the skin's outermost layer. Papillo- mavirus infection is a form of infection caused by the virus papillomavirus (HPV). Warts are skin lesions that vary in form depending on the HPV type and the climate. Adults and children alike will grow skin warts throughout their lives. Warts come in a number of sizes, but the most common are nodules and single or groups of elevated papules on the skin's surface, as shown in Figure 6 [19][24].

Fig. 6. Images of skin warts in children

The reason for choosing these five infectious skin diseases, the selected diseases differed and met in the speed and ease of spread of infection among children. The infection may spread through breathing or by touching contaminated surfaces or contacting wounds in the affected skin.

3.2 The design

Figure 7 describes the design of the proposed methodology. The input is the five dermatologists mentioned in the design phase. While the technique that have been chosen for this study is CNN. CNN is defined as consisting of multiple layers and mainly used for image processing and object detection. CNN is widely used in satellite image identification, medical image processing, time-series predication, and anomaly detection [3]. Hence it is the most suitable technique to be applied for this study. The output will be the predicted skin diseases based on the input and the technique have been applied this study.

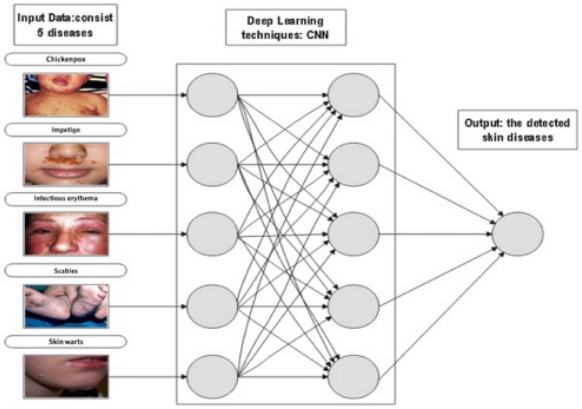

Fig. 7. Deep learning methodology

3.3 The implementation

Algorithm is a set of instructions for solving a problem correctly and effectively. The algorithm of the proposed methodology is shown in Figure 8. It shows the use of the necessary libraries, and then loading the dataset which are then divided into three folders with different proportions (training 80%, validation 15%, testing 5%) in each folder there were the five skin diseases. After that, The data in those folders has been explored. The proposed methodology processed the data so that it changes the size to 224 x 224 and used data augmentation such as zooming, cropping, rotation and brightness. After that, the VGG19 model was built and retrained it. The Adamax compile is appropriate for the VGG19 model. Early stopping was used to avoid over-fitting and under-fitting while training the model. Then the results of the over-fitting and under-fitting diagnosis are shown. At the end, the it evaluated the performance of the model and detected the five skin diseases by inserting the image and extracting the type of disease.

1. **BEGIN**
2. Import Libraries
3. Load dataset of images
4. Exploratory data analysis
5. **FOR i = 1** to **total number of images**
6. Data preprocessing: resizing images from 294×222 to 224×224 as a default size
7. Data Augmentation: using several techniques like zooming, cropping, rotating and brightness
8. Build VGG19 Model
9. **ENDFOR**
10. Compile VGG19 Model
11. **IF** predict overfitting **THEN**
12. use early stopping to avoid overfitting and underfitting
13. **ENDIF**
14. Executing VGG19 Model
15. **IF** training is 80% of dataset **THEN**
16. Use 15% of dataset for validation
17. **ENDIF**
18. Test data by splitting dataset which takes 5% of dataset
19. Diagnosis overfitting and underfitting
20. Evaluating performance of model
21. Prediction of skin disease
22. **END**

Fig. 8. Proposed algorithm

In the field of machine learning and neural networks, TensorFlow is the most widely used library [25]. As a result, Tensorflow was used as the project's backend. The coding environment utilized is Colab. TPU was created to speed up deep learning tasks. Figure 9 shows the proposed methodology flow.

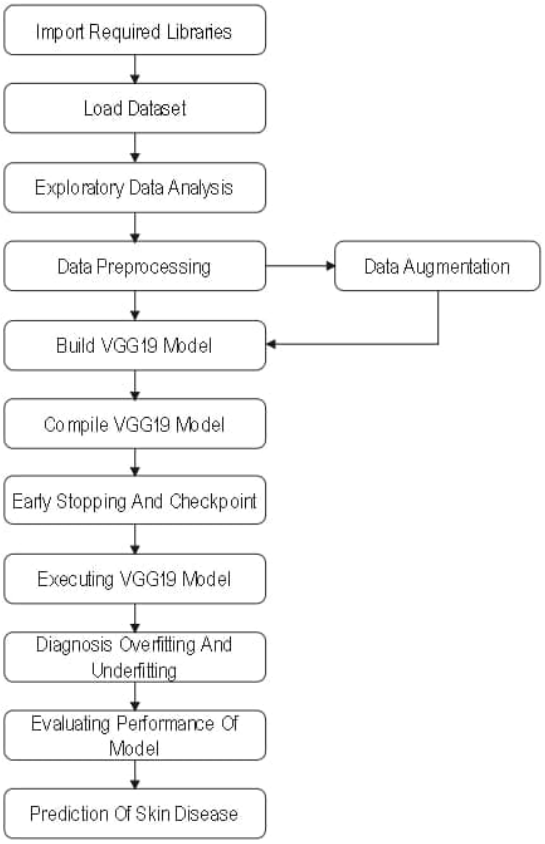

Fig. 9. Proposed methodology

Data preprocessing. It is a technique for detecting and investigating different types of images and producing the necessary output within the kind of image. To achieve excellent performance in a skin disease detection system, some main challenges must be overcome such as, combining image dimensions. The technique for image resizing and augmentation that was used in the proposed methodology is detailed in the following section.

Resizing. Before implement the code and train the model, it resized all the images from 294×222 to 224×224 as a default size. VGG19 was originally trained on the images with size 224×224.

Data augmentation. Image augmentation is a strong approach for creating new and unique images from a set of existing photographs. This is accomplished through the use of several transformation techniques such as zooming, rotating an existing image by a few degrees, shearing, and cropping an existing group of images [26]. Before training the model with a default value, it is rotated, rescaled, and horizontally flipped. Other enhancement techniques, such as zooming and brightness, will have an impact on the

detection process. This study will Apply the augmentation to three of the train photos in the folder.

Before training, the data, layers were modified in the previously tested VGG19 model. It added a flatten layer and three Dense layer with" Tanh" activation function, and at the end of the model it added one Dense layer with SoftMax activation function to predict five classes.

In the proposed methodology, adamax was chosen for the optimizer, it is the best optimizer because it trains the neural network in less time and more efficiently [27]. The learning rate is given as (0.0005) to make the training process more reliable, but the improvement will take more time [28]. The categorical crossentrop was chosen for the loss, because there will be multiple classification [29].

3.4 Testing procedure

The process of determining a model's validity is known as testing. The test was carried out in the proposed methodology by splitting a piece of the data by 5% for testing purposes. Test data predictions were made, and performance evaluation was used to assess accuracy. When assigned the training and validation batch size to 64 for 70 epoch the test accuracy gives 0.99.

4 Results and discussion

The major finding for this study is classifying the images of skin disease to predict one of the five skin diseases. Moreover, the proposed methodology achieved accuracy 99% on VGG19 model.

In Figure 10(a) it shows the train and validation accuracy. The train accuracy significantly increased from 0 to 35 epoch. The validation accuracy started increasing from 0 epoch, then decreased at 4 and then started increasing and decreasing to 35 epochs. In Figure 10(b) shows the train and validation loss. The train loss decreased when the epoch value increase. The validation loss is not fixed. It is increased and decreased in different values.

(a) (b)

Fig. 10. The accuracy and loss for the training model in each epoch

In Table 2 comparison between previous studies in the detection of infectious skin diseases, which proved that this study benefited from the analysis of each of the current factors and techniques and proposed methodology achieved better results.

Table 2. Comparison with previous studies

Reference	Title	Year	Techniques	Accuracy
[4]	Deep Neural Frameworks Improve the Accuracy of General Practitioners in the Classification of Pigmented Skin Lesions.	2020	DNN GAN	65%-70%
[7]	Classification of raisin grains using machine vision and artificial intelligence methods.	2017	KNN ANN SVM DT	82% 92.50% 89.50% 90%
[12]	A deep learning system for differential diagnosis of skin diseases	2020	DLS	71% 93%
[14]	Diagnosis of skin diseases using convolutional neural networks	2018	CNN	70%-90%
This Study	Skin disease detection for kids at school using deep learning techniques	2022	CNN VGG19	99%

5 Conclusion

In this study, five targeted types of infectious skin diseases common among school children were analyzed. After that, all previous studies related to this type of study were covered. The pro- posed methodology is designed to detect different skin diseases using deep learning technology based on what has benefited from the coverage of previous studies. A comprehensive analysis of previous studies was conducted more deeply, which led to chosen of the CNN technique, that is most suitable with the VGG19 model. And some improvements were made to the proposed methodology such as choosing the activation function "Tanh" with the hidden layers of the model and using data augmentation such as cropping, zooming, brightness, and rotating. In addition, the use of early stopping to avoid overfitting. Thus, this study obtained a higher accuracy. In conclusion, this proposed methodology provides an effective tool by achieving an accuracy of 99% which is very reliable, by allowing the use of different types of disease images for classification.

5.1 Future work

The proposed methodology proved to be reliable based on the high accuracy of 99% obtained. Further more, it can be integrated into the educational organization, schools, or any place where students gather and prone to skin diseases spread without the need for the intervention of specialized medical people in the place. More analysis can be carried out in the future in cooperation with the medical sector to investigate more about infectious diseases that may spread among children. The data obtained from the medical

sector will be collected and integrated into the Internet of Things (IOT) system as smart building to help detect diseases without the need for the intervention of medical sector.

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