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A Systematic Analysis for the Detection of Skin Disease Using Deep Learning Methodologies

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Abstract: Among the most common medical diseases is a skin disease, as the skin is the outermost layer of our body and can get affected more quickly. It is critical to combat this disease in its early stages and avoid the risk of it becoming life-threatening. Therefore, using the techniques of deep learning to identify skin diseases is necessary and has gained the attention of many researchers to work on it. In this review, we look at various efforts made by researchers to use deep learning technology to identify skin diseases. We provide a slight overview of skin diseases, including their types, skin disease datasets, and data preprocessing techniques. Then, we discuss the paradigm of deep learning and the well-known deep learning methods used by researchers for skin disease diagnosis. This study's main goal is to deliver a systematic literature review of skin disease detection based on deep learning methodologies used in recent research. As deep learning methodologies are well-known for providing more accurate results, our research observations also demonstrate that these methods for the skin disease image recognition system are better than dermatologists and several machine-based therapy strategies, as well as other classification methods.

Keywords: Skin disease diagnose, Deep learning, Convolutional neural network, Skin disease, skin disorder.

1. Introduction

Skin disease is a specific sort of disease that has become an issue all over the world. Our skin organ is of large size and serves as the body's first line of defense against harmful substances, the environment, and leakage of the body's many nutrients [1]. As it is the most outer layer of our body, the environmental conditions, bacteria's and viruses' infection, direct UV radiations, week immune system, fungus, contact with allergens and other skin affected person are some main causes of skin disease infection. These factors have a negative impact on human health, the integrity of skin function, as well as certain skin damage, and put lives in danger. Skin problems have become the most common chronic disease that people suffer from. Some skin diseases are due to situational causes, and some can be due to genetics. Some skin diseases can be of short time and some are of long period and can be life threatening. This disease has affected between thirty and seventy percent of people, placing them in the more severely damaged category [2]. Based on their 2018 Skin Foundation report, sixty percent of British citizens have a skin problem [3].

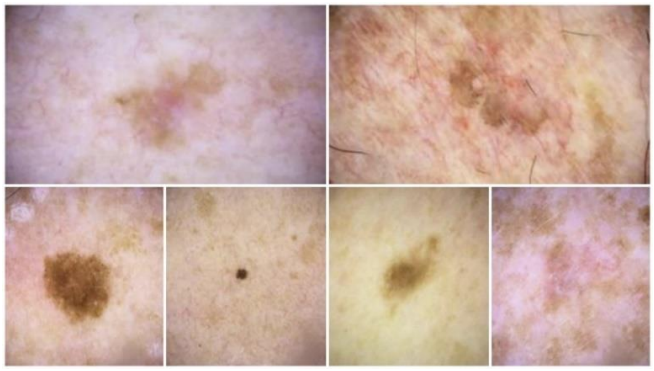

Figure 1. Skin Disease Images collected from ISIC dataset [7].

Early discovery is essential for skin disease therapy so as to heal the ailment, significantly lessen its effects, as well as raise life expectancies. Skin disease diagnosis has grown to be a significant scientific challenge. People employed machine-based like computer, diagnosis for skin disease detection based on the skin images previously to address the issues with skin disease diagnosis and treatment [4]. By benefiting patients, AI approaches can describe the four skin diseases that were examined [5]. The machine vision strategy and methods of image processing usage for the varied field of medical imaging has grown dramatically in recent years. Numerous manifestations of skin diseases are common, because qualified dermatologists aren't all in the same places due to an uneven distribution, there is a high demand for rapid, precise diagnostics that are based on data. In comparison to previous models, deep learning models categorize data and images more effectively. Deep learning models can adapt to changes in the situation. They can also automatically find features in the data they are given, which could help them solve a lot of problems. Even with the most basic computer models, deep learning models can use inferred data to find and study patterns in data that haven't been shown to them. This makes them very efficient. It is possible to identify skin-related diseases from dermatological images using supervised techniques such as fuzzy systems and artificial neural networks (ANN), which have the benefit of feature extraction methods. Additionally, k-nearest neighbors (KNN) is also a classification method that may be used to differentiate normal from abnormal images by grouping pixels based on their similarity in each feature image [6].

As a solution to these problems, we've come up with deep learning algorithms that actively gather information and automatically pull out features from the data by utilizing feature extraction methods. These methods can deliver precise diagnostic results while resolving common feature extraction problems. Currently, a convolutional neural network (CNN) in deep learning is being used as the main approach for skin disease image recognition. The CNN has excellent feature representational superiority. Applying deep learning techniques to the detection of skin diseases has been the topic of these articles [8, 9, 10, 11, 12]. For instance, Esteva et al. [8] proposed a methodology for categorizing all different skin diseases based on a pretrained CNN classification method. They considerably surpassed the abilities of human experts, with top-1 and top-3 classification accuracy rates of 60.0% and 80.3%, respectively. Deep neural networks are capable of handling the wide variety of skin disease images by learning useful features. Considering advancements in this technology, however, the widespread application of deep learning in the diagnosis of skin diseases has been constrained by the unavailability of a large volume of labelled clinical data.

This article gives a systematic literature analysis of recent researchers' effort to use deep learning to diagnose skin diseases. We begin by providing a sufficient overview of skin problems. We next describe standard data collection techniques through literature research and list some widely used and freely accessible datasets for skin diseases for training and testing deep learning models. Therefore, by reviewing studies that have been published up through the year 2022, we provide a thorough summary of the difficulties in the classification of skin disorders and offer appropriate answers in this article. It provides readers a lot of information about the pros and cons of using deep learning to find skin diseases.

2. Methodology

In this research article, researchers use popular deep learning methodologies used for the detection of skin diseases. Below Figure 2 depicts the four layers systematic methodology process. This article's primary goal is to analyze the commonly used deep learning methodologies for the detection of skin disease.

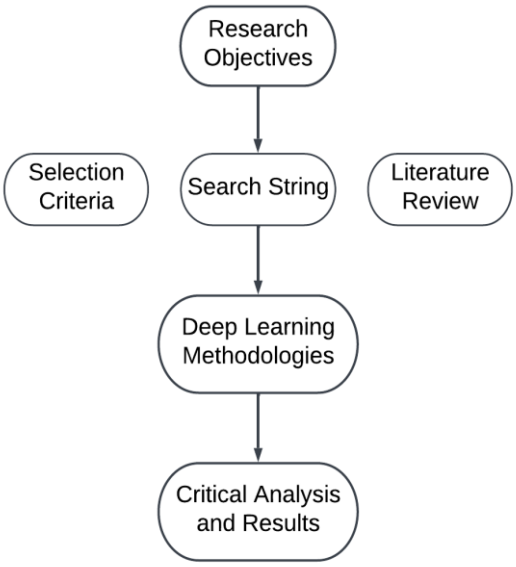

Figure 2. Systematic Methodology Process.

2.1. Research Objectives

This article's objective is to evaluate the progress and improvements in the detection of skin disease by using deep learning methods and machine learning approaches. Every methodology got advanced and improved over time. This study presents the improvements of these methods as well as current research on skin disease detection and benefits of deep learning methodologies over other algorithms. This article shows the critical analysis of deep learning algorithms applied practically for skin disease detection.

2.2. Selection Criteria

Identification and selection of research articles that suit our research analysis for skin disease detection based on deep learning methodologies, which is the main objective of this article, helps us to analyze those specific research articles. Below is the Table 1 to present this article's Inclusion criteria and exclusion criteria.

Table 1.The Inclusion criteria and Exclusion Criteria.

Inclusion Criteria	Exclusion Criteria
1: Publications providing briefing and implementation of Skin disease	1: Articles that just describe skin disease but not implement it
2: Publications that provide implementation of methods that classify skin disease	2: Articles that are not providing implementation methods of skin disease to be classified
3: Publications that provide methodology to detect skin	3: Articles that are not implementing methods for

disease by the use of deep learning	detection of skin disease by the use of deep learning
4: Publications that have been authored in English	4: Articles that not have been authored in English
5: Articles that are published after 2012	5: Publications that are published pre 2012

2.3. Search String

1. (“skin disease” OR “skin disease classification” OR “disease skin” OR “skin disease detection” OR “skin disorder” OR “skin care” OR “skin infection”) & (“deep neural network” OR “dnn” OR “deep learning” OR “convolutional neural network” OR “cnn” OR “support vector machine” OR “svm”)
2. (“skin” OR “skin disorder” OR “skin diagnose” OR “epidermis” OR “epidermis abnormality” OR “epidermis disorder” OR “dermis” “dermis abnormality”) & (“deep neural network” OR “dnn” OR “dl” OR “deep learning” OR “convolutional neural network” OR “cnn” OR “support vector machine” OR “svm”)

3. Literature Review

To identify the various types of skin diseases, researchers urge the use of image processing-based approaches. As in [12], researchers suggested a system for the segmentation of skin disorders using images. It used two algorithms to identify infected skin and an ANN classification to classify the disease. The method was evaluated on six different skin disease types, and the first stage and second stage accuracy averages were 95.99% and 94.016%, respectively.

The first stage in the approach of [20] for detecting melanoma, a skin disease, requires the extraction of image features using computer vision. In this process, the more image features that are extracted, the more accurate the system becomes. Artificial Neural Network (ANN) technique is used where they identify nine different skin disease types with up to 90% accuracy.

In [21], the author concentrated on the analysis of various segmentation methods that may be utilized to identify melanoma through image processing. The segmentation procedure that uses the boundaries of the diseased spot to extract more information is discussed. They used Support vector machine (SVM) for skin lesions classification employed by PH2 dataset. The accuracy achieved is 92.5%

Researchers in [8] proposed a method for categorizing all skin diseases based on a convolutional neural network that has been GoogleNet Inspection V-3 pretrained (CNN). They used clinical imaging datasets of skin cancer and dermatoscopic images. They considerably surpassed the abilities of human experts with top-1 and top-3 classification accuracy rates of 60.0% and 80.3%, respectively.

A method to assess skin infection using a combination of machine learning and computer vision techniques was developed by Kumar et al. [22]. Skin disease is assessed using ML, and features were retrieved by CV. For the detection of infection, Region-based CNN techniques were deployed including three methodologies in it. The accuracy of the result is 95%.

Researchers in [23] suggested a methodology that can quickly classify eczema, a dangerous skin disease. The suggested methodology contains three different sections, in which the segmentation is done in the first section. Feature extraction is done in the second portion, and an SVM classifier is used for eczema disease classification at the end.

In [24], Researchers proposed optimal probability-based DNN method to identify four different kinds of skin diseases and used Whale approach for optimization. This proposed model contains training and testing phases. The accuracy is 95%.

Researchers in [25] proposed a technique consist of 2 different stages. In first stage, feature optimization has been done by using two procedures. In which the addition of average correlation coefficient with error's probability along with Fisher method are used. In second stage, they used multilayer perception (MLP), which is a machine vision classifier to get better accuracy in the presence of huge, complex and noisy dataset. The accuracy they achieved is 97.1%.

Researchers in [26] used computer vision to identify four different skin diseases. Convolutional Neural Networks (CNN) having 11 layers are used in this method and established AlexNet model. Softmax used as a Classifier to detect Acne, Keratosis, Eczema herpeticum, and Urticaria, which are the kinds of skin disease taken from the DermNet dataset. The total accuracy was 98.6%.

In [27], Researchers used fine-tuned technique on VGG-16 model with 16 layers having same size convolutional filters in which 13 layers are Convolutional and 3 are connected layers. Researchers trained the parameter using ImageNet dataset. The total accuracy was 83.5%.

The design and functioning of deep neural networks are discussed in this article, with a focus on how they might be applied to the detection and treatment of various diseases. Deep learning, which is based on a machine learning approach, is capable of handling complicated mappings. Deep neural networks are a well-liked technique for processing and assessing medical data due to their dependability and resemblance to how humans think and act [13]. Deep learning, which consists of numerous processing layers, enables computer models to discover data representations at various levels of abstraction with little manual scheme required [14].

4. Deep Learning Methodologies

Deep Learning methodologies have significant importance as these are known for producing much better results, and we can update these algorithms according to our requirements to get more accurate results. For skin disease detection, these methodologies have mostly been used in recent research. After reviewing the research works on skin disease classification, the following are the most popular deep learning techniques for skin classification:

- Artificial Neural Network
- Convolutional Neural Network
- Deep Neural Network
- Support Vector Machine
- Multi-layer perception

4.1. Artificial Neural Network (ANN)

Artificial neural network (ANN) is an effective tool for handling complex problems like signal amplification, signal identification, and signal and factor prediction as well as classification tasks. A crucial quality of ANNs is their flexibility. As a result, they can be applied in circumstances when it is not possible to create a formal numerical model [15], but where there is a sufficient sample size [16]. Figure 2 shows the architecture of an artificial neural network.

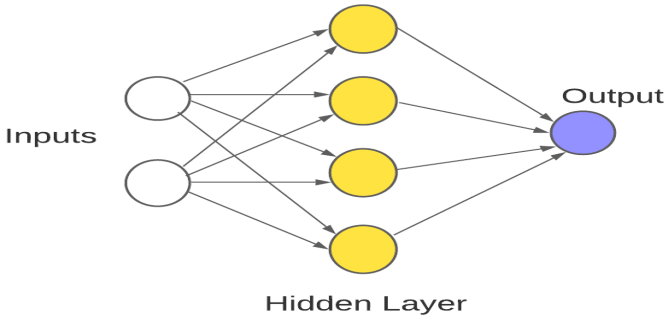

Figure 3. ANN Model.

4.2. Convolutional Neural Network

Convolutional Neural Network is a deep learning-based algorithm. CNN is an established method in the field of image processing and computer vision. CNN is made up of the three layers named as an input layer, output layer and hidden layers. The middle layers in a forward pass CNN are known as hidden layers because activation function (ReLU), pooling layer, and convolution are used to conceal them. Figure 3 depicts the forward pass convolutional neural network's structural layout.

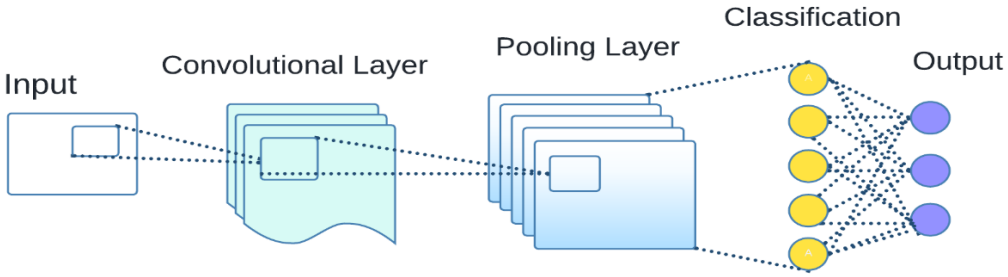

Figure 4. Convolutional Neural Network.

4.3. Deep Neural Network (DNN)

In a simple Deep Neural Network model, the input layers process various hidden layers to create the output layer [17]. It is capable to differentiate between several unstructured data types. In order to extract features at various levels of abstraction and then learn more complicated patterns, DNNs have a number of advantages to efficiently extract input data features. DNNs compute their internal parameters in the forward pass and then iteratively adjust them during back-propagation. A DNN model is shown below in Figure 4.

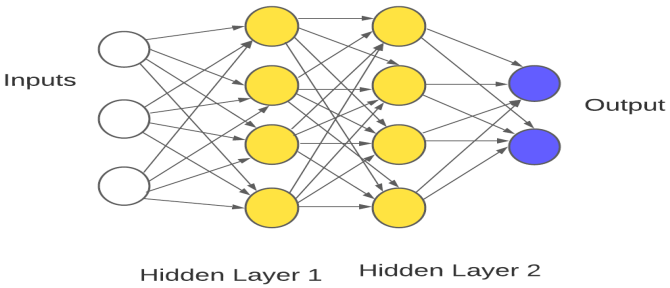

Figure 5. DNN Architecture.

4.4. Support Vector Machine

Support Vector Machine is a powerful classifier for classifying data, a rapid iterative technique, a nonlinear function estimator [18], etc. To find the optimum hyper-plane, it use supervised machine learning to learn from training sets of labelled tuples. The aim is to classify the hyper plane, which can witness several classes. As various hyper planes can perform this task, the one with the largest margin that shortens the distance among classes is to be identified. The new and most recent data point that needs to be classed can be simply categorized by that aforementioned hyper plane [19]. Figure 5 shows the model of SVM.

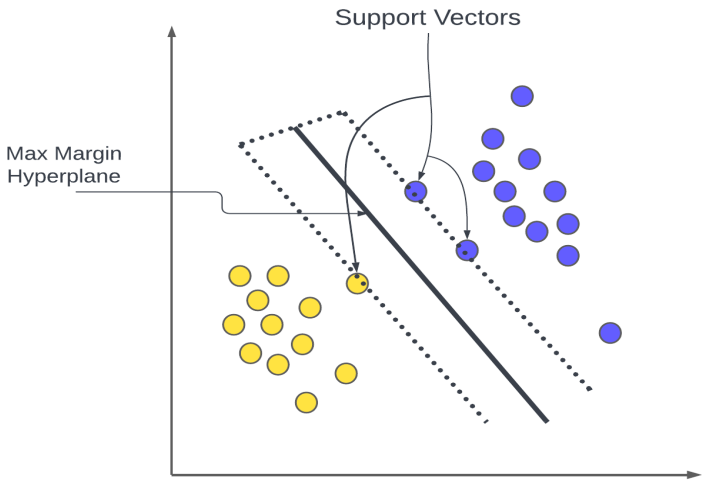

Figure 6. SVM model.

4.5. Multi-layer perception (MLP)

Multilayer perception (MPL) contains three different layers, in which the input layer serves for receiving input, the output layer serves for prediction or classification, and the needed amount of hidden layers are positioned within those two layers, and data flows from these layers towards the output layer in a forward direction [25]. A model of Multi-layer perception is shown in Figure 6 below.

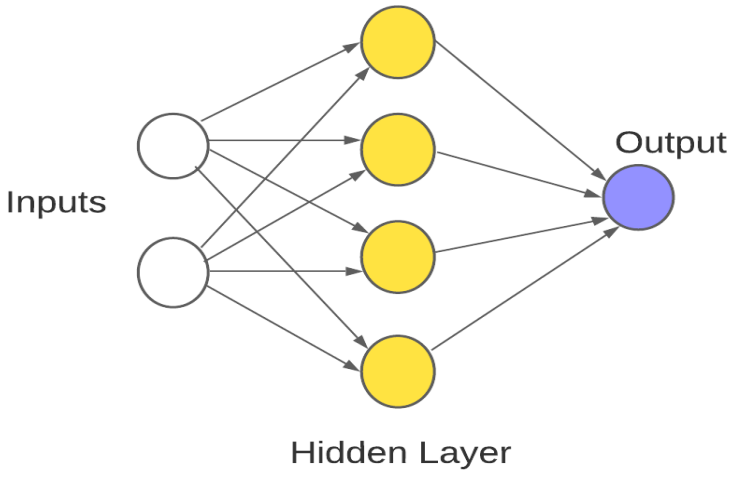

Figure 7. Multi-Layer Perception.

5. Discussion

Deep learning techniques have received a lot of attention and show signs of progress for skin disease diagnosis. A significant amount of research and creative system development are needed to design and validate effective models or algorithms that enable new techniques for imaging [28]. Dermoscopic inspection by dermatologists has a key problem in that the method is subjective and the outcomes might change with expertise. Early and effective diagnosis of skin diseases is often hampered by factors including the training, time, and expertise required to use a variety of current and emerging approaches. A comprehensive decision support system has not been created, despite the fact that numerous automated approaches for diagnosing skin diseases have been created. Currently, a CNN network in deep learning is used as the principal approach for skin disease image recognition.

The results of this study show how deep learning methods are widely used in the classification and prediction of skin diseases. Research on many algorithms can become more advanced, but to some extent, deep learning techniques are able to detect skin disease with a higher accuracy rate. In order to improve patient diagnosis, treatment, and therapy, it is crucial to perceive deep learning as an approach to getting better overall results. The table 2 below clearly shows the comparison of all algorithms' accuracy.

Table 2. Comparison between Algorithm's Accuracy

References	Classification	Methodology	Accuracy
[8]	Convolutional Neural Network	GoogleNet inspection V-3	80.3%
[12]	Artificial Neural Network	Computer Vision	94%
[20]	Artificial Neural Network	Computer Vision	90%
[21]	Support Vector Machine	Computer Vision	92.5%
[22]	Artificial Neural Network(R-CNN)	Computer Vision	95%
[23]	Support Vector Machine	Computer Vision	90%
[24]	OP-Deep Neural Network	Computer Vision	95%
[25]	Multi-Layer Perception	1st order histogram + gray level co-occurrence matrix	97%
[26]	Convolutional Neural Network	AlexNet	98.6%
[27]	Convolutional Neural Network	VGG-16	83.5%

The above table shows that deep learning has demonstrated greater accuracy than other methods in a quick comparison of algorithms used for the detection of skin diseases. However, given that numerous deep learning-based image analysis techniques are currently being tested on moderate size datasets, and these deep learning methods like AlexNet, GoogleNet Inspection, and VGG are commonly used and capable of presenting better accuracy results for skin disease classification. MLP approach also shows very good accuracy result which proves this method is capable to apply on huge and complex dataset than others. This study is anticipated to contribute to a better understanding of the several skin disease classification algorithms that are currently available.

6. Conclusion

In this review, we have examined a few prominent machine vision and deep learning techniques that use limited amount of images data on skin diseases currently available. It has been noted that the development of deep learning has the greater advantage of offering reliable and accurate diagnoses in automated decision making for speedier and more accurate diagnoses in the processing of medical data. This work's main objective is to comprehend the deep learning methods utilized for skin disease diagnosis. Deep learning classification and prediction models can reduce the number of false positives for diagnosing skin diseases and can provide incredibly trustworthy and accurate diagnoses that could put patients in risk. Thus, the models can assist patients and healthcare professionals everywhere in enhancing public health and global health. The most recent developments show that in order to achieve the aim of faster and more accurate processing, additional work is required in the areas of feature representation, dimensional reduction, and minimal processing overhead. We analyzed the most commonly used deep learning algorithms for skin disease detection, including their performance and a comparison of their accuracies, and found that deep learning models are way more reliable, give more accurate results than others, and are used widely for skin disease detection.

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