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AI-Driven Skin Disease Detection and Classification: Leveraging CNNs for Multiclass Diagnosis

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Abstract

Because it is the biggest organ in the body and covers the muscles, bones, and other elements of the body, the function of the skin plays an extremely important part in the functioning of the human body. When one of the functions of the skin becomes impaired, it has a domino effect on the rest of the body. Because the skin is the most sensitive organ, the development of skin cancer is more likely to occur when it is exposed to UV radiation and other forms of environmental pollution. There are two distinct types of skin cancer: benign and melanoma. Melanoma, on the other hand, creates sores on the skin, which may lead to bleeding. It is named after the cells in the skin called melanocytes, and it is a more serious condition. Benign moles on the skin do not spread into the deeper layers of the skin. According to the estimates provided by the American Cancer Society, physicians in the United States identify more than 700,000 cases of skin lesions each year. Statistics provided by Apollo and other hospitals indicate that the age range of patients who are diagnosed with melanoma is between 41 and 60 years old and higher. In the early stages of skin cancer, it is possible to diagnose the disease using several technologies. People's lives may be saved by early detection of skin cancer, which also stops the spread of cancer cells to other regions of the body and prevents the proliferation of cancer cells. Even though it only affects persons of a certain age, the risk is much higher for those with fair skin. Even for an expert dermatologist, it will be difficult to diagnose skin cancer and difficult to anticipate the phases of the disease. As a result, a wide variety of hardware and software applications and devices developed.

1. Introduction

Skin illnesses are a significant public health concern in nations with high incomes as well as those with low incomes, and they are the fourth greatest source of the burden of non-fatal skin disorders [1]. Skin diseases are also the fifth most common cause of death from skin disorders. Skin diseases may be brought on by a wide variety of reasons, such as overexposure to ultraviolet (UV) radiation, tanning, genetic susceptibility, environmental factors, consuming alcohol, and so on [2][3]. These elements influence the skin, and the damage they cause may be detrimental to its health. Skin conditions have the potential to bring about a variety of unfavourable outcomes, some of which include social isolation, a physical disability, self-inflicted injuries, physiological changes, difficulty maintaining relationships, unemployment, alcoholism, and even death in the case of malignant melanoma. It has been established that patients who are suffering from skin diseases have a greater risk of suicidal thoughts and attempts than those who do not have skin diseases. [4]. It is estimated that sixty percent of people living in the United Kingdom will suffer from some form of skin issue at some time in their life. [5]. The classification of skin problems requires extensive domain expertise, specialised equipment, and in-depth knowledge, and there is a substantial gap between the number of individuals who suffer from skin conditions and the resources that are required to treat them [6]. People who reside in countries where the average income is low often do not have access to the services that are being discussed here. Because of this, there is a significant need for intelligent expert systems that can carry out multi-class skin lesion classification and provide individuals with assistance in early diagnosis. This is necessary to minimise the problems that are caused by skin ailments. Some people might benefit from this. Acne, eczema, and melanoma (both benign and malignant) are three of the top five most frequent skin diseases [7] in the world. As a result of this, the objective of this research endeavour is to design and create an intelligent expert system that can classify sthese skin ailments. In our earlier research, we explored the categorization of skin lesions using the conventional machine learning technique [8]. When we referred to a standard machine learning technique, we were referring to a computational method for the classification of skin lesions. This method includes many steps, and classification is carried out with the help of manually extracted features. Within the scope of this study, we looked at the degree to which the convolutional neural network, which is a subsection of the deep neural network, is accurate at classifying data. A multi-class classification issue may be broken down into a group of binary classification problems with the use of an ECOC classifier [9]. Because SVM is the machine learning approach that is used most often for the categorization of skin lesions [10], we have decided to make use of SVM for the classification process. The intelligent expert system that has been suggested is able to differentiate between skin conditions such as healthy, acne, eczema, benign, and malignant lesions.

There are six primary categories of cancer, which are as follows: 1) Carcinoma is a kind of cancer that begins in the cells of the skin, pancreas, lungs, breasts, and a variety of other organs and glands; 2) Carcinoma has the potential to spread to other areas of the body. 2) Sarcoma is a kind of cancer that may begin in any of the body's connective tissues, including bone, cartilage, muscle, fat, blood vessels, or any of the other possible locations; 3) Leukemia begins in the tissue that is responsible for the generation of blood, such as the bone marrow, and leads to the production of a considerable number of abnormal blood cells; 4) Lymphoma starts in the lymph nodes, whereas multiple myeloma starts in the skin. 5) Multiple myeloma starts in the bone marrow. 6) Melanoma is a kind of skin cancer that develops in the cells of the skin that are accountable to produce pigment. Melanomas tend to affect people with darker skin tones. It has the potential to spread to other organs and may begin in the skin but can also begin in other tissues.

2. Literature survey

Hameed et al. [11] suggested for an intelligent diagnostic technique that would classify a wide variety of skin lesions into their respective categories. First, the proposed system is set into motion by making use of a hybrid technique, namely, a deep convolution neural network in combination with an error-correcting output codes (ECOC) support vector machine. This is done to ensure that the outcomes are as favourable as they may be (SVM). The objective of the categorization system that is now under consideration is to assign photographs of skin lesions to one of the following five unique categories: melanoma that is benign, healthful, acnetic, or eczematous; melanoma that is malignant. This classification process has been devised, implemented, and evaluated. Experiments were carried out on a total of 9,144 photos that were gathered from a variety of sources. In order to extract the features, a pre-trained CNN model called AlexNET was castoff. The ECOC SVM classifier was used in order to accomplish classification. When ECOC SVM is used, an accuracy of 86.21% may be achieved overall. In order to prevent overfitting, a method called 10-fold cross validation was utilized.

Kolkur et al. [12] proposed the use of machine learning methods to the diagnostic process of many different categories of human skin disorders. It is possible that patients may need to wait for treatment because there are not enough readily available medical facilities. This, in turn, may increase the probability that the sickness will become more severe or that it will spread to other people. It is crucial to get a diagnosis of these problems at an early stage in order to avoid this from happening. We devised a system that, given a set of symptoms as input, can determine the illness in question. With the assistance of an authority in the area, we were able to collect data on the symptoms of ten different skin illnesses. Several different classifiers were educated using the data from the symptom. We scored 90% or better in terms of accuracy.

An intelligent digital diagnostic strategy was presented by Hameed et al. [13] to increase the classification accuracy of numerous disorders. In order to meet the issues presented by the study, a classification algorithm known as Multi-Class Multi-Level (MCML) is being investigated. This method draws its inspiration from the "divide and conquer" strategy. Both time-tested methods of machine learning also cutting-edge deep learning are included into the MCML classification algorithm's actual workings. The conventional method to machine learning is given a facelift with the introduction of certain enhanced noise reduction strategies. The proposed technique is tested on 3672 labelled pictures obtained from a variety of sources, and it is shown to attain a diagnosis accuracy of 96.47%. Therefore, in order to verify the performance of the recommended algorithm, its metrics are compared with those of the Multi-Class Single-Level classification algorithm, which is the primary approach that is used in the vast majority of the published research. This is done so that the performance of the recommended algorithm can be verified. The findings suggest that the MCML classification technique has the potential to improve the classification performance of a number of different skin lesions, which is the last point but certainly not the least. The results support this interpretation of the conclusion.

3. PROPOSED METHOD

In this project, we are classifying skin illnesses based on photographs using CNN (convolution neural networks), which has gained a lot of success and popularity in the area of image classification. We have used a dataset of skin diseases to train CNN. This dataset includes nine distinct types of skin diseases, including "Actinic Keratosis," "Basal Cell Carcinoma," "Dermatofibroma," "Melanoma," "Nevus," "Pigmented Benign Keratosis," "Seborrheic Keratosis," "Squamous Cell Carcinoma," and "Vascular Lesion." After the CNN algorithm has been trained, we are able to input any test picture, and the CNN algorithm will identify and diagnose illness based on that image. Fig. 4.1 is a schematic showing the proposed system's block layout.

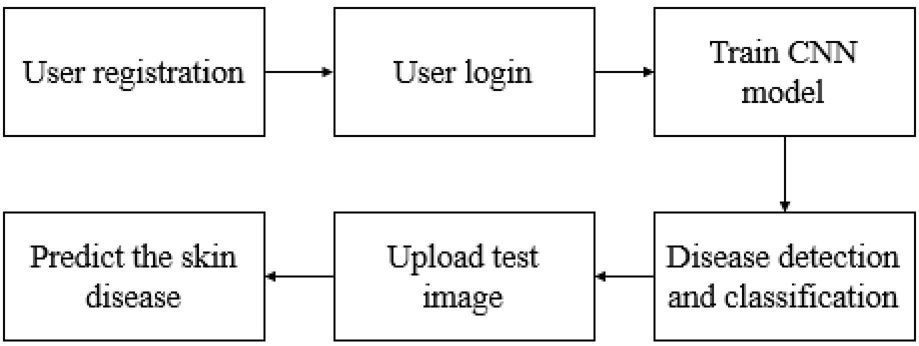

Fig. 1: Block diagram of proposed system.

Deep learning (DL) techniques, which are swiftly becoming one of the most extensively utilised approaches for a broad range of tasks including picture recognition and computer vision, have quickly become one of the most popular methods because of their better performance. The performance of these techniques has been shown to be superior than that of prior methods that were based on shallow

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structures, and this has been shown in image classification, natural language classification, and image segmentation. Even if the majority of DL techniques are capable of doing automated feature extraction, extreme care is still essential when picking a strategy to apply in the course of working on a certain endeavour. Convolutional neural networks, also known as CNNs, have proven to be more effective than deep neural networks within the context of the aforementioned methodologies when it comes to the task of producing a representation of the input data that includes grid-type data, such as photographs or matrices.

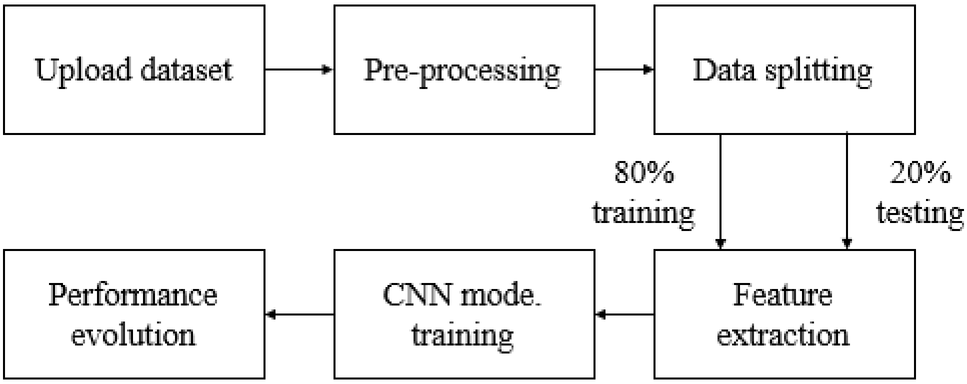


Fig. 2: Proposed system for DL-CNN model training.

Because of its superior performance, deep learning (DL) methods have quickly become one of the most widely used approaches for a wide variety of tasks that include image identification and computer vision. In image classification, natural language organization, and image segmentation, the performance of these approaches has been proven to be superior than that of earlier methods that were based on shallow structures. Even though the majority of DL approaches may do automated feature extraction, significant caution is nevertheless required when selecting an approach to use in the course of dealing with a particular endeavour. In the context of these methods, convolutional neural networks (CNNs) have been shown to be superior than deep neural networks when it comes to producing a representation of the input data including grid-type data, such as pictures or matrices.

Before trying to appreciate how CNNs operate, it is required to first be acquainted with the functioning of a one-layer feedforward network (FFN). This is a prerequisite for understanding how CNNs work. Consider the neural network that is shown in Figure 1 as an illustration for this scenario. An FFN needs the data vector x that is supplied as input, a weight matrix W1 that corresponds to the input layer, and a bias vector b1 in order to construct a vector of values for the hidden layer. These three things are necessary in order to do this. This is seen in equation (1), where the variable f is a representation of an activation function such as a sigmoid function or a rectifier linear unit (ReLU) function. Using equation (2), we can determine that the output vector y is formed from the hidden unit vector h, in addition to an additional weight matrix W2 and bias vector b2 (which characterise the connections between the hidden and the output layers).

$$h = f(W^1 x + b^1) \quad (1)$$

$$y = W^2 h + b^2 \quad (2)$$

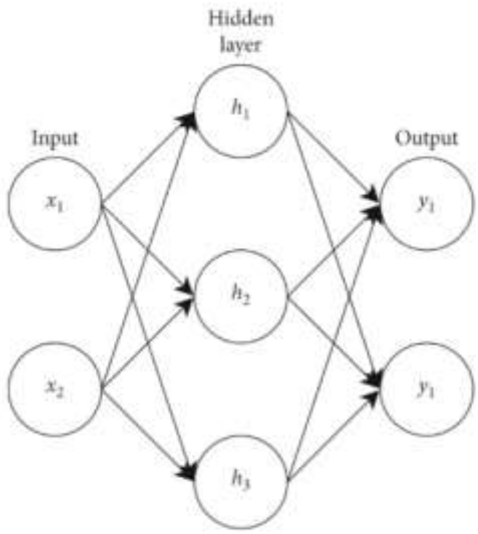
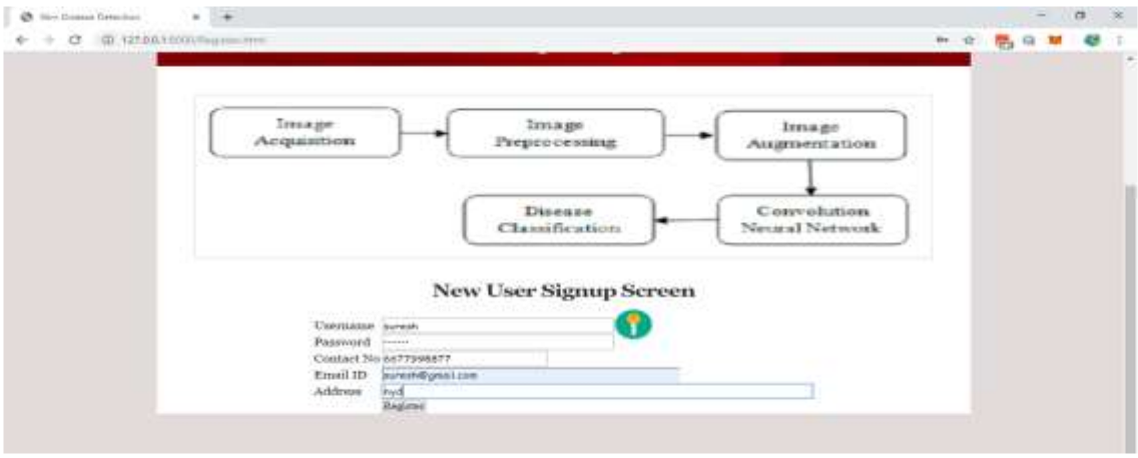


Figure 3. 3-hidden-unit feed-forward neural network with 2-output values.

4. RESULTS

To access the registration page below, click the "Register Here" link on the screen that is shown above.

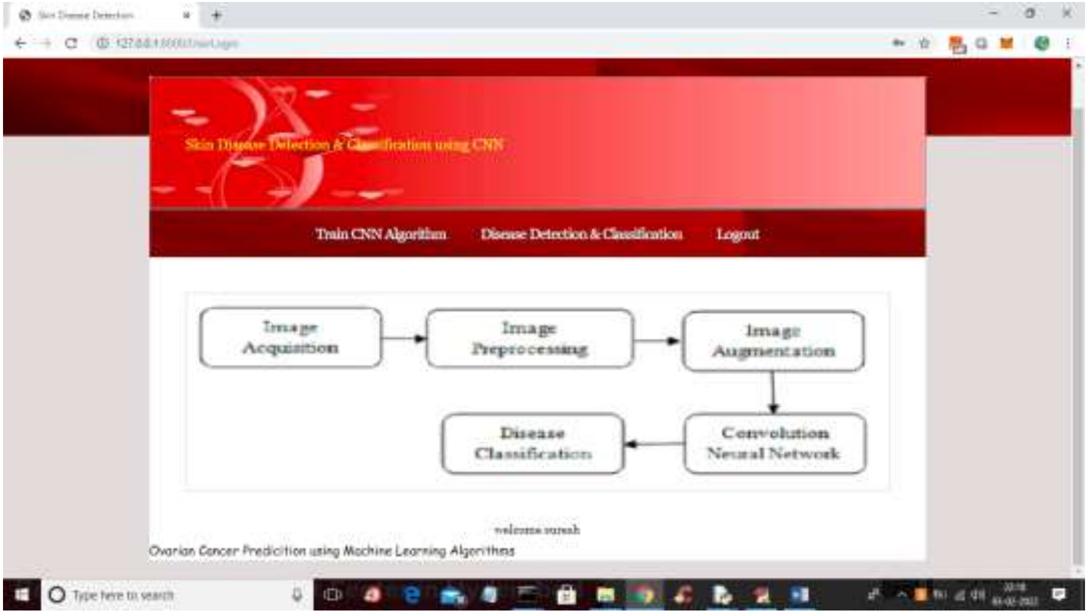


The user must first input their registration data on the page shown above, and then they must click the "Register" button in order to finish the signup process and see the result shown below.

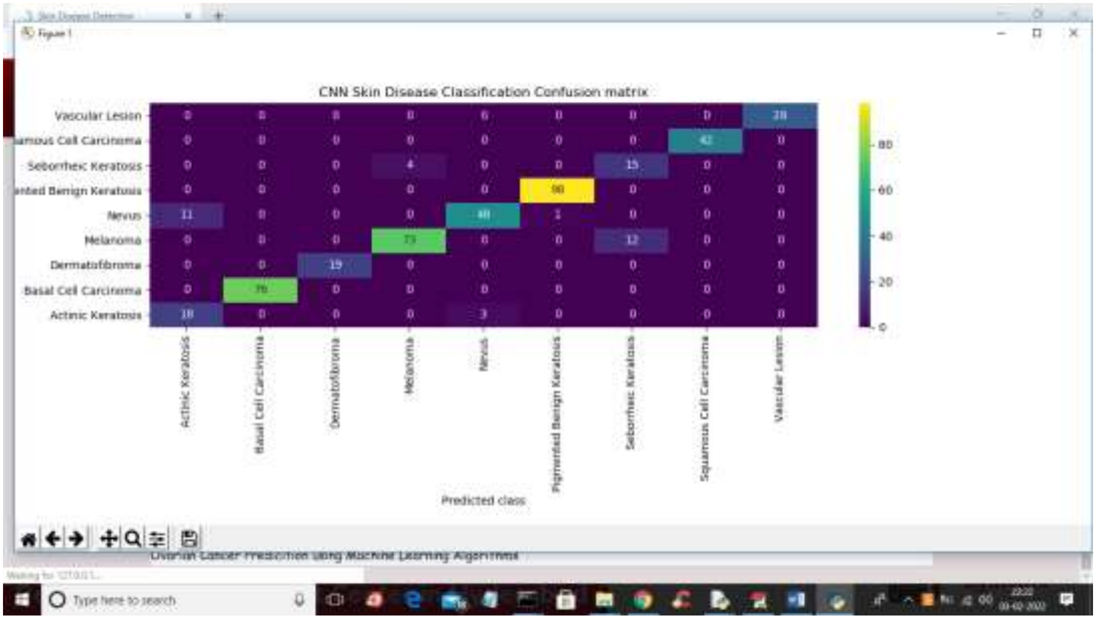
When we look at the page above, we can see that the registration procedure has been finished in blue font, and we may now click the 'Login' link to go to the screen below.

On the page that is seen above, the user logs in, and then they click the 'Login' button to go to the screen that is displayed below.

ISSN: 0975-3583, 0976-2833 VOL13, ISSUE 08, 2022



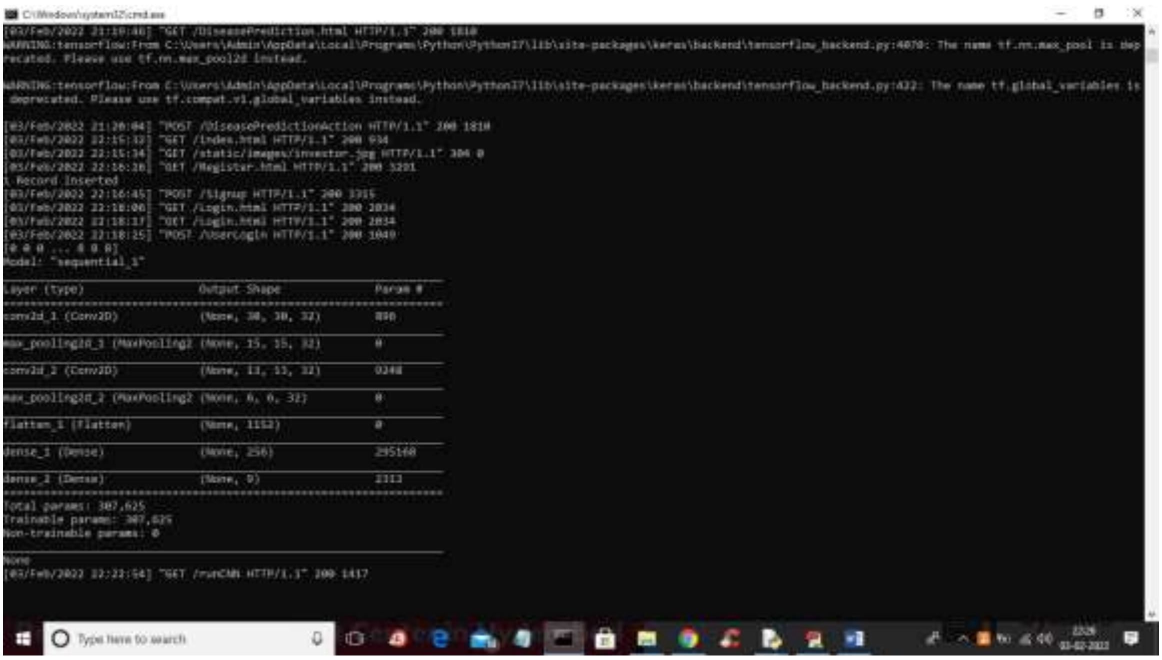
On the page that you see above, the user may train CNN by clicking the link that says "Train CNN Algorithm" to acquire the result that you see below.



In the preceding CNN confusion matrix graph, we are able to make predictions on test data. The x-axis of the preceding graph represents predicted disease names, and the y-axis of the preceding graph represents the original test classes. In the preceding graph, all of the values that are contained within the diagnol boxes represent the correct prediction, whereas values greater than zero that are not contained within the diagnol boxes represent the incorrect prediction. Now you can reach below CNN accuracy by closing the graph above.

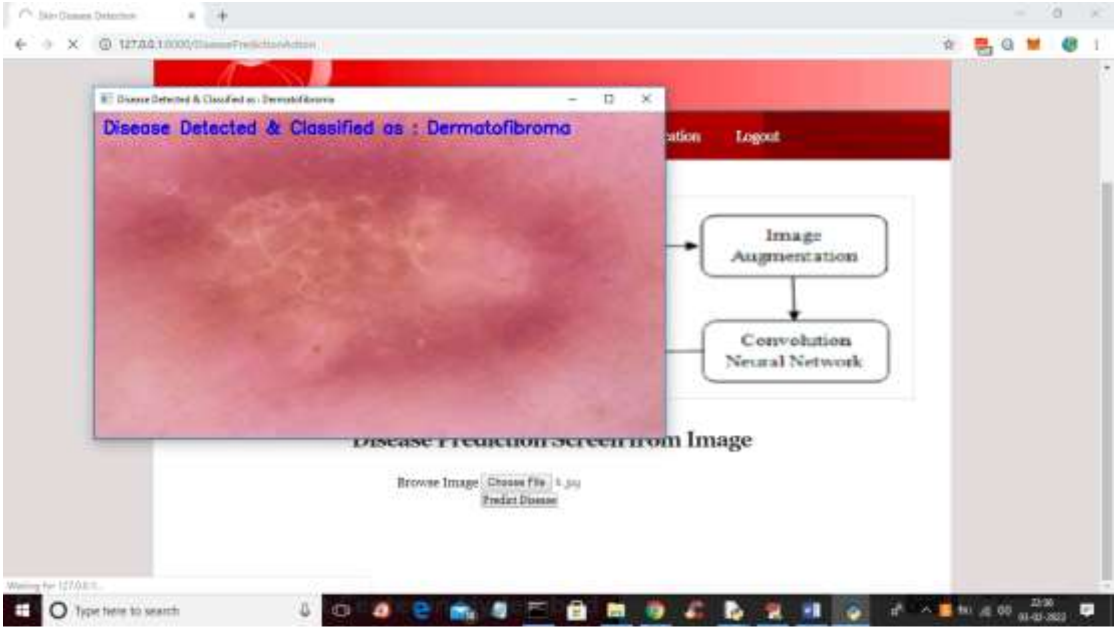
ISSN: 0975-3583, 0976-2833 VOL13, ISSUE 08, 2022

On the screen above, we can see that CNN has an accuracy of 93%, while on the screen below, we can see CNN's architecture.



In the CNN architecture described above, we have constructed numerous layers with a variety of picture sizes, including 30 x 30, 15 x 15, and so on. Now go back to the output application, and once there, click on the link labelled "Disease Detection & Classification" to get the results seen below.

ISSN: 0975-3583, 0976-2833 VOL13, ISSUE 08, 2022



5. CONCLUSION

For the purpose of archiving the system's maximum efficiency and contributing to this research, a deep learning convolution neural network, abbreviated as DL-CNN, was constructed inside this framework for the multi-class classification of skin cancer. The results of the research may, thus, be effectively applied to the classification of all nine unique types of skin cancer. In further iterations of our study, we will make more improvements to use re-enforcement learning in order to properly categorise skin lesions.

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