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Conference Paper

# Performance of the CNN Method for Identifying Health Conditions Based on Nail Images

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ABSTRACT

Generally, someone who feels sick in his body wants to know his actual health condition by visiting a doctor at a hospital or other health service center for a medical examination. The doctor will ask about the symptoms experienced by the patient and sometimes examine several parts of the body to get important information before he diagnoses the patient's health condition. Theoretically, based on research developments in the medical field, changes in conditions (related to color, texture, and shape) on fingernails or toenails indicate changes in the health condition of a person's body. When someone has a health problem, the body's nerves will send signals to the fingernail or toenail area, and then the physical condition of the nail changes color, texture, and shape. These changes occur slowly, according to the condition of a person's body. Each type of health disorder or disease in the body will produce unique nail changes. Visually, the physical changes of the nails are often not very visible, but if you look closely, these changes do occur. Our research proposes an intelligent system (an artificial intelligence-based software application) to automatically diagnose body health conditions using photos of fingernails. The analysis process is carried out on the nail image to find out whether someone has health problems or not. The system for detecting body health conditions automatically using photos of nails produced in our research has a relatively good performance, namely an accuracy of 86.45%, a precision of 0.78, a recall of 1.0, and an f1 score of 0.88.

*Keywords: Health disorder diagnosis, nail photo analysis, artificial intelligence*

## Introduction

Health is a very important factor in everyone's life. If a person is healthy, then he will be able to do many things well. On the other hand, if a person is not healthy, many activities cannot be done. Ideally, health needs to be maintained in the long term, not just now. A person who feels healthy today may be sick tomorrow. A person's body condition may have health problems, which he does not feel at this time but will appear when the body's defenses are no longer able to fight the increase in these problems (due to disease, decreased organ function due to lifestyle, or other factors). Thus, efforts to detect health conditions early are very important, especially for those who are experiencing symptoms of an unhealthy body. Efforts to find out about health conditions are usually carried out through consultations or medical examinations with doctors at hospitals or other healthcare centers. The doctor will ask about the symptoms experienced by the patient and sometimes examine several parts of the body to obtain important information before diagnosing the patient's health condition. The general examination process carried out by doctors is illustrated in Figure 1.

Theoretically, based on research developments in the medical field, changes in conditions (color, texture, and shape) on fingernails or toenails can be an indication of changes in health conditions in a

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person's body (Indi & Patil, 2019). When a person experiences a health problem, the body's nerves will send signals to the fingernail or toenail area, and then the physical condition of the nails undergoes changes related to color, texture, and shape (Maniyan & Shivakumar, 2018). These changes occur slowly or little by little, depending on the condition of a person's body. Each type of health disorder or disease in the body will produce unique nail changes. Visually, at a certain level, the physical changes of these nails may not be very visible, but if you look closely, these changes do occur. Doctors who have medical knowledge and experience can see these changes visually (using their eyes). This then becomes the basis for doctors to diagnose whether their patients are experiencing health problems or not. The doctor may carry out a further examination if it is necessary or to find out more detail about the health disorder. It could be that the patient is actually in a normal or healthy condition, even though he has complaints of pain. Complaints of pain are not always caused by health problems that occur in the physical body, they can also be caused by psychological conditions that give rise to feelings of pain, which the body then responds to like a sick condition. So that the treatment can be just psychological or lifestyle improvements, no further medical treatment is needed.

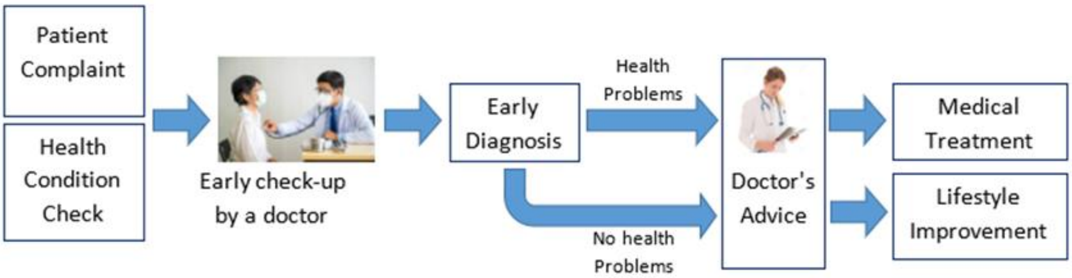


Figure 1. Initial examination of health problems by a doctor

The Intelligent System for Analyzing Nail Photos proposed in this research is intended to help the analysis or diagnosis process automatically, such as with a doctor's expertise. This knowledge of expertise in the diagnosis process will be adopted into artificial intelligence software using a neural network machine learning method that is specifically designed to automatically diagnose body health conditions based on photos of nail objects on fingers or toes. Specifically, the diagnosis results are a normal or healthy body condition (not having health problems) or illness (having health problems). Health problems that can be detected through these nails include iron deficiency, autoimmune diseases, allergy symptoms, thyroid disease, and other health problems caused by viruses, bacteria, or a lack of important substances in the body that cause certain organs or body parts to be disturbed.

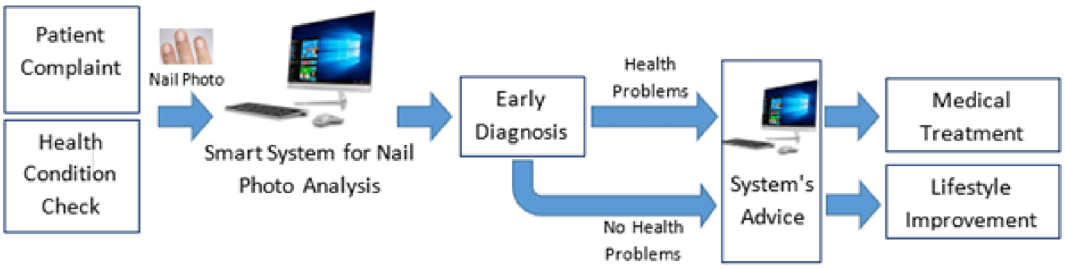


Figure 2. Initial examination of health problems using the Smart System

The process of diagnosis through nail photos can be an early warning related to a person's health condition. Everyone needs to control their health early, which can then be followed by a series of further medical treatments. This research proposes a process for automatically detecting body health conditions using nail photos, which will later become the basis for developing an intelligent system for health diagnosis through nail image analysis. An illustration of an intelligent health diagnosis system is shown in Figure 2. By using a smart system to analyze nail photos for health condition diagnosis, everyone, especially those who are experiencing complaints of body pain, can carry out an early self-examination. If later you have to go to a doctor, then it is related to further medical treatment that is needed.

Nail image analysis is a very important research topic to study. This is caused by the relationship between the condition of the nails and the health condition of the human body. Many diseases that cause health problems in the body can be diagnosed by analyzing the condition of the nails (Indi & Patil, 2019). Many of the methods that researchers have created are connected to machine learning. In the area of analyzing medical data, artificial neural networks (ANN) and deep learning (DL) techniques have so far demonstrated astounding results (Zemouri et al., 2019). Deep learning-based technologies that are widely used in disease diagnosis, include convolutional neural networks, autoencoders, deep belief networks, and generative adversarial networks (Abraham et al., 2020). The CNN approach performs exceptionally well in machine learning. Researchers have used this CNN model in health studies to examine a variety of disorders, including prostate cancer diagnosis (Abraham & Nair, 2018; Abraham & Nair, 2019), breast cancer (Celik et al., 2020), brain disease (Talo et al., 2019), leukemia (Doan et al., 2020), and so on.

The CNN method was developed using several changes. One instance is the creation of a model using a CNN ensemble to find COVID-19 (Abraham & Nair, 2021). Another study utilized CNN with the Retina Net model with Mask R-CNN to enhance the performance of pneumonia identification (Sirazitdinov et al., 2019). In another study, the usage of 10 convolutional networks for COVID-19 identification was discussed (Ardakani et al., 2020). The use of various picture modalities to aid in quicker illness identification was highlighted by Horry et al. (2020). By combining filter and wrapper methods and classifying using ensemble learning techniques, Shaban et al. developed a new approach to feature selection (Shaban et al., 2020). In other studies, the CNN design is changed to include four convolutional layers, four max-pooling layers, one flattening layer, and seven dense layers, as well as a data augmentation procedure (Stephen et al., 2019). Additionally, SqueezeNet was used to create a light convolutional neural network model (Polsinelli et al., 2020). The embedded graph knowledge Additionally, the CNN approach was created during the data training procedure to enhance classification performance (Xu et al., 2021). Similarly, earlier research evaluated the ability of CNN models to identify pneumonia, including VGG16, VGG19, ResNet50, and Inception-v3 (Jain et al., 2020). A transfer learning strategy that involves fine-tuning the previously trained network was created by Phankokkruad et al (2020). Hanumanthu (2020) and colleagues describe several deep learning and transfer learning techniques used for disease early detection.

In our study, body health disorders will be identified using machine learning and nail photo analysis. The neural network model architecture of the Convolutional Neural Network (CNN) method, which will be modified in many ways to discover which model architecture delivers the best performance, will be used in the selected classification methodology. As was said in the section before, there is a significant amount of other researchers' work that is included in the CNN architecture. In this study, a CNN architecture that is pertinent to the issue of nail photo analysis is established.

## Material and Methods

*Machine learning architecture*

The model architecture used in our study's convolutional neural network technique is depicted in Figure 3. In our study, machine learning employs the CNN approach, which consists of feature extraction and classification as its two fundamental steps. Using the feature extraction technique, features that are numerical representations of the image are created from the image. The convolutional layer and the pooling layer are the two components of this procedure. The neurons in the convolutional layer are arranged to create a filter with length and height (pixels) from their arrangement. While identifying picture objects is done through the classification method.

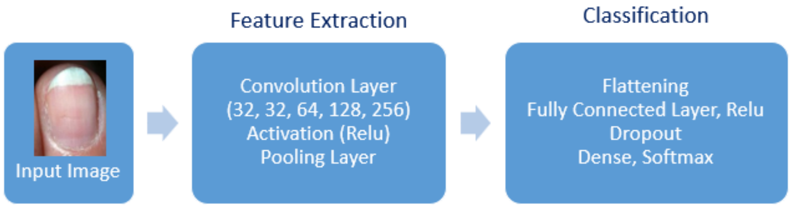


Figure 3. CNN model in the research

The CNN approach goes through numerous steps during implementation, including model development, model training, model evaluation, and final model prediction. Figure 4 depicts the CNN architecture employed in our study's health-based nail image analysis. According to the figure, the CNN architecture that we utilized consists of an input layer, five convolutional layers, five rectified linear units (Relu), five max-pooling layers, two fully connected layers (FCL), two dropout layers, Softmax, and one classification layer (output layers). A 3x3 filter with dimension values of 32, 32, 64, 128, and 256 is present in the convolution layer.

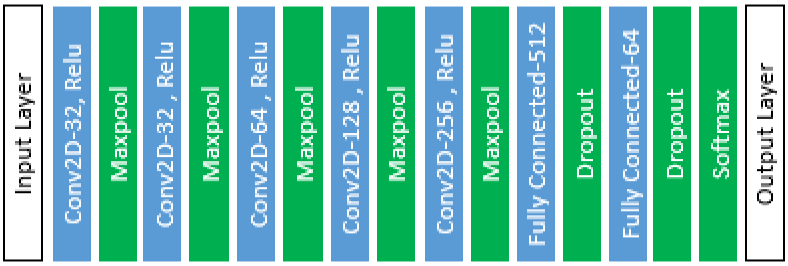


Figure 4. CNN architecture

The output of the preceding layer is subjected to a convolution operation by the convolution layer. This layer serves as the foundation of a CNN. Convolution on image data is used to take features out of the source image. According to the spatial information in the input data, convolution will result in a linear transformation of the data. The convolution kernel used is specified by the weights on the layer, allowing the convolution kernel to be learned using the input to the CNN. To make the picture smaller so that it may be quickly replaced by a convolution layer with the same stride as the related pooling layer, the CNN pooling layer is utilized. When applying MLP, the fully connected layer seeks to change the dimensions of the data so that it can be categorized linearly. Before entering a fully linked layer, each neuron in the convolution layer must be converted into one-dimensional data. The completely connected layer can only be used at the network end because doing so causes the data to lose its spatial information and is irreversible.

*Dataset*

The image dataset for the experiment in this study consists of a collection of digital photographs of fingernails that have been divided into normal (healthy) and pathological (unhealthy) conditions. An illustration of a fingernail having these two circumstances is shown in Figure 5.

Figure 5. Nail image showing healthy (left) and unhealthy conditions (right)

The image dataset used in our experiment is split into three primary groups: training data, validation data, and evaluation data, each of which includes a collection of nail image data in both healthy and diseased settings. 3,115 photos of healthy nails and 3,115 images of unhealthy nails make up the 6,230 images training dataset. There are 1,304 photos total in the dataset for validation, 652 of which are of healthy nails and 652 of which are of sick nails. While there are 192 photographs total in the dataset for examination, including 96 images of healthy nails and 96 images of damaged nails. This dataset's organization is used to evaluate a method for determining body health based on the recognition of nail photos. In keeping with the testing protocols decided upon by professionals in this field, our research uses the Convolutional Neural Network approach with 22 layers.

**Results and Discussion**

By changing several parameters, including the input image size, convolution layer, and other factors, the experimental procedure is repeatedly applied to the program code. To get the best performance outcomes, this must be done. The best performance outcomes are attained based on the outcomes of the trials that have been conducted, as illustrated in Figures 6 to 9. Accuracy, precision, recall, and F1 score are used to evaluate performance in this study.

Figure 6 illustrates the accuracy in the training and validation process, with the training accuracy in the most recent epoch being 74.37% and the validation accuracy being 83.28%.

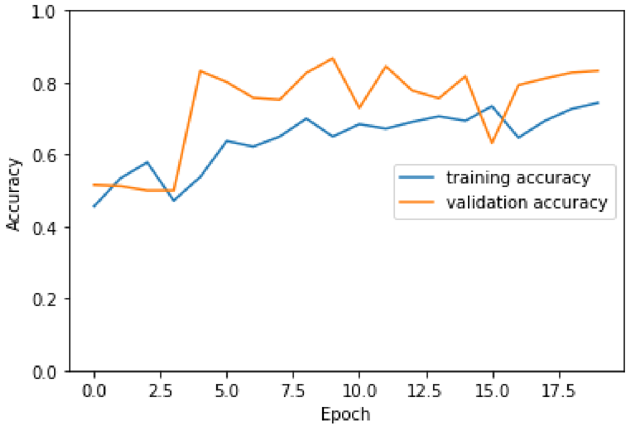


Figure 6. Performance result: Accuracy in training and validation

Figure 7 illustrates the precision in the training and validation process, with the validation precision being 0.75 and the last epoch having a precision of 0.67.

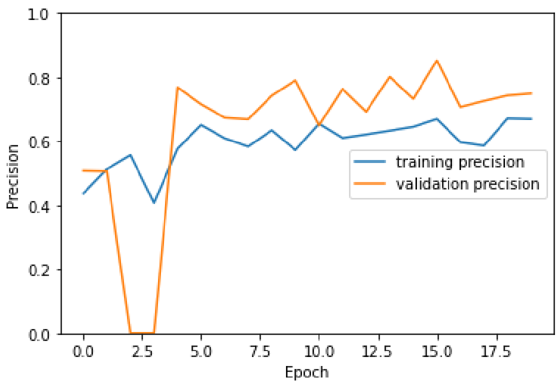


Figure 7. Performance result: Precision in training and validation

Figure 8 depicts the recall in the training and validation process, with the training recall in the most recent epoch being 0.97 and the validation recall being 1.0.

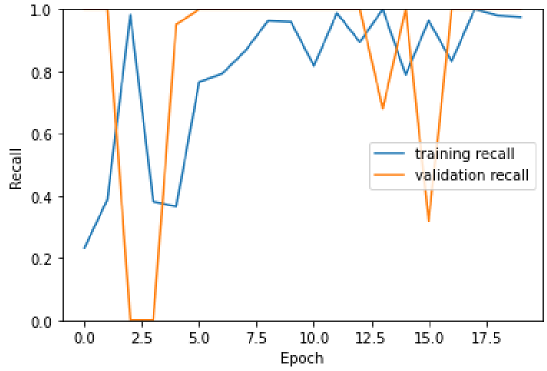


Figure 8. Performance result: Recall on training and validation

The loss in the training process is shown in Figure 9, where the validation loss in the most recent epoch was 0.50 and the validation loss in the previous epoch was 0.39.

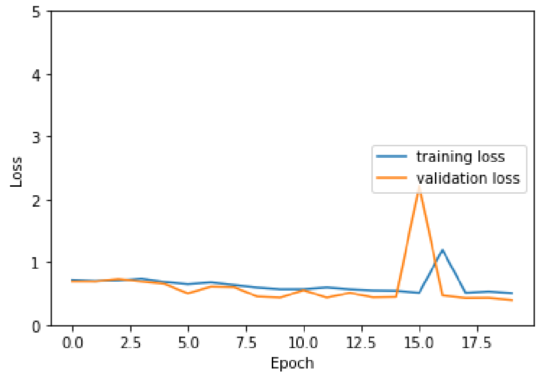


Figure 9. Performance result: Loss in training and validation

The final evaluation's findings demonstrate reasonably strong performance, with an accuracy of 86.45%, precision of 0.78, recall of 1.0, and f1 score of 0.88.

## Conclusion

According to the findings of the experiments we conducted, the automatic detection of body health issues using nail images in this research performed reasonably well, with 86.45% accuracy, 0.78 precision, 1.0 recall, and 0.88 f1 scores. The performance findings achieved still need to be tested with a bigger dataset because the trial process used a small sample size of images.

The accuracy of the automatic bodily health state identification utilizing this nail image still has to be increased, but it can already perform more than 90% of the time. To identify the characteristics that prevent the system from accurately detecting images, more analysis of the image classification process must be done. Reexamining the data processing architecture and comparing it to different architectures created by researchers in this field are two additional analyses that can be done to eventually obtain an architectural arrangement that can produce better detection performance.


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