Detection of Pneumonia using Deep Transfer Learning

Dr.NATHALIE JOHN
Assistant Professor
isha84210@gmail.com

Dr.WINSTON DUNN
Student
miteshpatil9201@gmail.com

Dr.REGAN MOODY
Student
prasaddeshmukh3444@gmail.com

Changu Kana Thakur Arts, Commerce & Science college, New Panvel (Autonomous)

Abstract

The health is the most important part of the human life. There are many diseases that affect the human body and one of them is pneumonia. Pneumonia is a bacterial or viral disease of the lungs. It affects many people, particularly in undeveloped and poor countries with high levels of pollution, unsanitary living conditions, overcrowding, and limited medical facilities. With the help of Deep transfer learning it is possible to detect the Pneumonia. Chest X-ray imaging is the most regularly used method for diagnosing pneumonia. Even though the examination of chest X-rays is challenging and prone to subjective variability. In this research, we developed a com puter-aided diagnosis method for automated pneumonia identification using chest X-ray pictures. To deal with the lack of accessible data, we used deep transfer learning and created an assembly of three convolutional neural network models: Google Net, ResNet-18, and DenseNet-121. A heaviness average group technique was adopted, in which the weights assigned to the base learners were determined using a novel approach.

Keywords: ***Pneumonia, chest X-ray, diagnosis ,Deep Learning, Convolutional Neural Network.***

Introduction

Pneumonia is a common respiratory infection that can affect people of all ages, especially those with weakened immune systems or underlying health conditions. Early and accurate detection of pneumonia is crucial for effective treatment and management of the infection. Currently, chest X-rays are the most commonly used imaging modality for pneumonia diagnosis. However, the interpretation of these images can be subjective and prone to errors, leading to potential misdiagnosis and delay in treatment. In recent years, the development of automated systems for pneumonia detection using X-ray images has shown promising results in improving the accuracy and efficiency of pneumonia diagnosis. This paper explores the use of machine learning and computer vision techniques for automated pneumonia detection from chest X-ray images and discusses the potential benefits and challenges of such systems in clinical practice.

Among patients under the age of five, India accounts for about 23% of the worldwide pneumonia burden and 36% of the WHO regional burden. There are no reliable estimates of illness burden, especially for the adult population. The scant evidence for adults comes from tertiary care teaching hospitals utilizing cross-sectional research. A new study emphasizes the role of bacteria in invasive bacterial disease in India. Case deaths range between 14 and 30% in all CAP patients and 47% in SCAP [9].

Several studies have demonstrated the effectiveness of these automated systems in detecting pneumonia from chest X-ray images with high accuracy and specificity, comparable to that of human radiologists. Moreover, these systems can provide quantitative measurements of the extent and severity of pneumonia, which can aid in treatment planning and monitoring. However, there are also challenges associated with developing and deploying such systems, such as data privacy concerns, ethical considerations, and the need for clinical validation.

Overall, the development of automated systems for pneumonia detection using X-ray images has the potential to revolutionize pneumonia diagnosis and management, improving patient outcomes and reducing healthcare costs. In this work, we developed a computer-aided diagnosis method for automated pneumonia identification using chest X-ray pictures. To deal with the lack of accessible data, we used deep transfer learning and created an assembly of three convolutional neural network models: Google Net, ResNet-18, and DenseNet-121. A heaviness average group technique was adopted, in which the weights assigned to the base learners were determined using a novel approach.

Literature Review:

Kaushik V et.al. in the paper presented in conference "Pneumonia Detection Using Convolutional Neural Networks (CNNs)" discusses about how pneumonia is a kind of interstitial lung disease that is the biggest cause of mortality in children lower than the age of five. The majority of the infants affected were under the age of two, and research was done to reliably diagnose pneumonic lungs from chest X-rays. The first, second, third, and fourth models were given to medical practitioners for use in treating pneumonia in the actual world. The models presented at best could achieve 92.31% accuracy [1].

D. Varshni et.al. in the paper presented in conference "Pneumonia Detection Using CNN Based Feature Extraction," focusses about how pneumonia is a potentially fatal infectious illness caused by the bacterium Streptococcus pneumoniae that affects one or even both lungs in people. According to the World Health Organization (WHO), pneumonia is responsible for one out of every three deaths in India. An automated approach for identifying pneumonia might be helpful in diagnosing pneumonia, especially in distant places. CNNs have been employed for illness classification tasks, and this study evaluates the effectiveness of pre-trained CNN models used as feature extractors followed by various classifiers for the categorization of abnormal and normal chest X-rays. The results suggest that pretrained CNN models and supervised classifier algorithms can be useful in detecting Pneumonia in chest x-ray pictures [2].

Mohammad Farukh Hashmi et.al. in the research paper "Pneumonia Detection in Chest X-Ray Images using Compound Scaled Deep Learning Model" elaborates about how pneumonia is the top cause of mortality in children under the age of five globally. Biomedical image diagnostic approaches have a lot of potential in medical image analysis. A model for detecting pneumonia based on chest X-ray images has been presented. ResNet50 is a residual-blocking multilayer layer convolution neural network. To expand the training dataset, data preprocessing techniques were applied. In training the models, transfer learning is also used. The suggested model was tested for overfitting and generalization errors and statistically verified. The proposed model attained an accuracy of 98.14%, a high AUC score of 99.71 and an F1 score of 98.3 [3].

Patrik Szepesi et.al. the research article "Detection of Pneumonia using Convolutional Neural Networks and Deep Learning," elaborates about how pneumonia presents a significant imaging difficulty because the symptoms of the condition are not often visible on CT or X-ray scans. In order to diagnose pneumonia, a unique deep neural network design is proposed in this paper that makes use of dropout in the network's convolutional layer. A set of 5856 labelled photos from one of Kaggle's medical imaging challenges, including chest X-rays from retrospective partners of paediatric patients aged one to five years, were used to train, and evaluate the suggested technique. Results are 97.2% accuracy, 97.3% recall, 97.4% precision and AUC=0.982 [4].

Kundu R. et.al. the research article “Pneumonia Detection in Chest X-Ray Images using an Ensemble of Deep Learning Models” focusses about how Pneumonia is a respiratory ailment caused by high levels of pollution, unsanitary living conditions, and overcrowding. To ensure effective treatment and survival, it must be diagnosed as soon as possible. Chest X-ray imaging is the most popular way to diagnose pneumonia, but it is subject to subjective variability. This study established a computer-aided diagnosis system for automatic pneumonia detection using deep transfer learning and an ensemble of three convolutional neural network models. Using the Kermany and RSNA datasets, the suggested technique achieved accuracy rates of 98.81% and 86.85%, as well as sensitivity values of 98.80% and 87.02% [5].

Scope

It is designed to detect the possibility of pneumonia using x-ray images.

Limitations

It is not used for treatment purposes.

Motivation

The motivation for developing a model for pneumonia detection is to provide a more efficient and accurate method for diagnosing pneumonia by using 3 CNN layers. By leveraging advances in artificial intelligence and machine learning, pneumonia detection can potentially improve the speed and accuracy of pneumonia diagnosis, allowing for earlier detection and treatment of the disease, which can ultimately save lives.

Methodology

The proposed pneumonia detection system using the ’Densely Connected Convolutional Neural Network’ (DenseNet-169) . The architecture of the proposed model has been divided into three different stages - the pre-processing stage, the feature-extraction stage, and the classification stage.

A. The Pre-Processing Stage

In most picture classification applications, the major purpose of employing Convolutional Neural Network is to lower the computational difficulty of the model, which is likely to grow if the input includes images. The original three-channel photos were downsized from 10241024 to 224224 pixels to decrease computation and speed up processing. All subsequent procedures have been applied to these reduced photos.

B. The Feature-Extraction Stage

Despite the fact that the features were extracted using several types of pre-trained CNN models, the statistical results obtained suggested DenseNet-169 as the best model for the feature extraction step. As a result, this step is concerned with the description of the DenseNet-169 model architecture and its role in feature extraction.

1) Architecture of DenseNet-169

DenseNet-169 is a pre-trained Densely Connected Convolutional Neural Network of 169 layers used for image recognition. It comprises of one convolution and pooling layer, 3 transition layers, 4 dense blocks, and a classification layer. The first convolutional layer performs 7x7 convolutions with stride 2, followed by a max pooling of 3x3 with stride 1. The network consists of a dense block, 3 sets of layers, each consisting of a transition layer followed by a dense block. DenseNets are used to overcome gradient vanishing by connecting all the layers with equal featutre-sizes directly with each other, allowing for more generic features to be obtained.

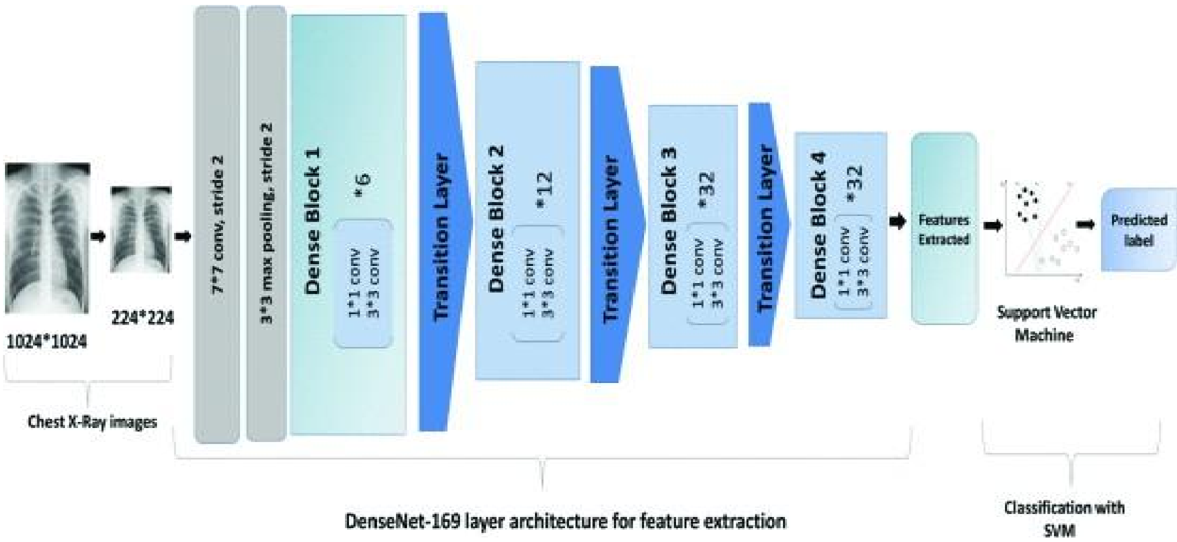


Fig. 1. Represents a flow diagram of our methodology applied [10].

2) Extraction of Features

The process of feature extraction from the model explained in this section 4.2.1 applies all the layers of the network except the final classification layer. The final feature representation obtained were interpreted as a 50176×1 dimension vector which then supplied as input to different classifiers.

C. The Classification Stage

The classification task was conducted using classifiers such as Random Forest and Support Vector Machine (SVM). The best results were achieved when Support vector Machine was used as classifier for the problem. Parameters and Kernel used with SVM include the Gaussian 'radial basis function' kernel (rbf) and the gamma and C parameters of RBF kernel. The gamma parameter measures the inverse of radius of the influence of samples selected as support vectors, while the C parameter compensates for misclassification of training samples.

Datasets

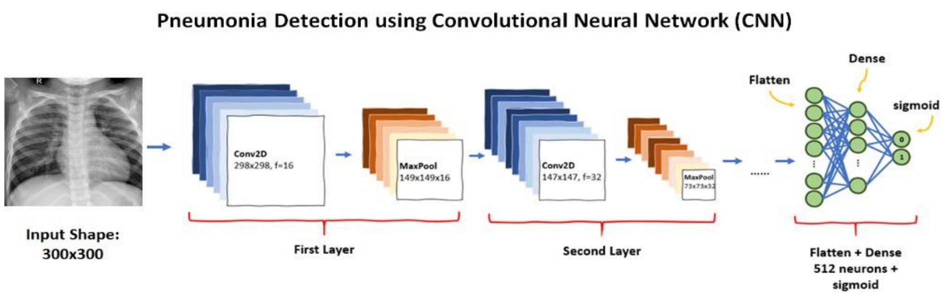
For every classification research during the training and testing phases, a suitable and sizable datasets is necessary. The Pneumonia Dataset, which includes a variety of chest x-ray images and their labels, is where the dataset for the experiment is downloaded from Kaggle. It includes a selection of photos taken in various settings. Downloaded is a collection with 15081 chest x-rays images divided into 2 classes, including normal chest x-ray images and the chest x-rays containing pneumonia.

Table no: 1 lists the samples from the dataset for each class.

Table No: 1

Sr. No	Types of images	No of images
1	Normal chest x-ray images	9806
2	Pneumonia chest x-ray images	5275
Total		15081

Model development:



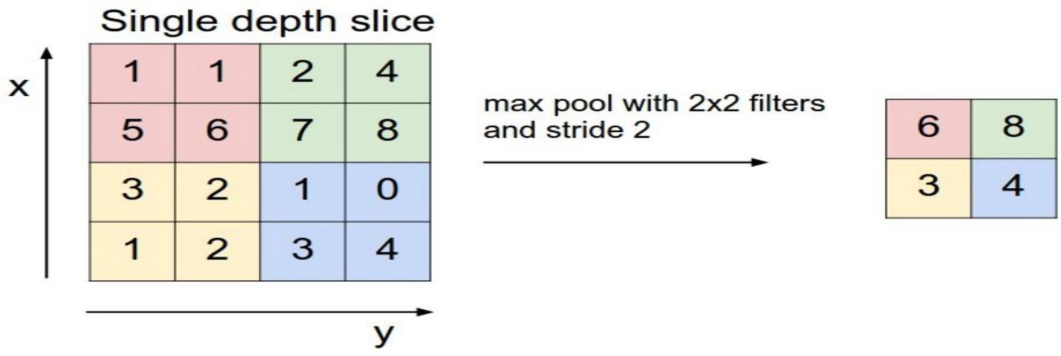
[6]

Convolutional layer:

A convolutional layer is a type of layer in a neural network that is specifically designed for processing data that has a grid-like structure, such as images, videos, or audio signals.

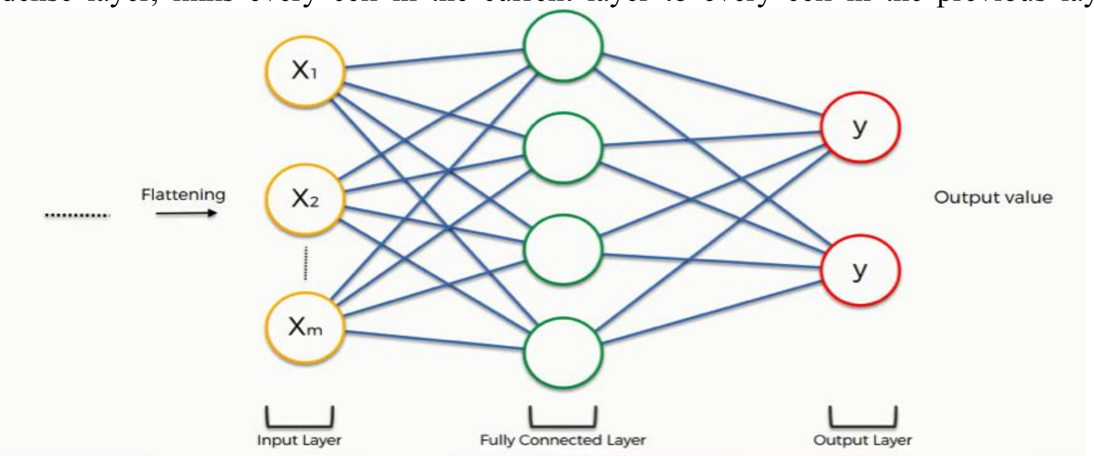
Pooling layer:

A pooling layer is a type of layer commonly used in convolutional neural networks (CNNs) to reduce the spatial dimensions (width and height) of the input data while preserving the important features.[7]



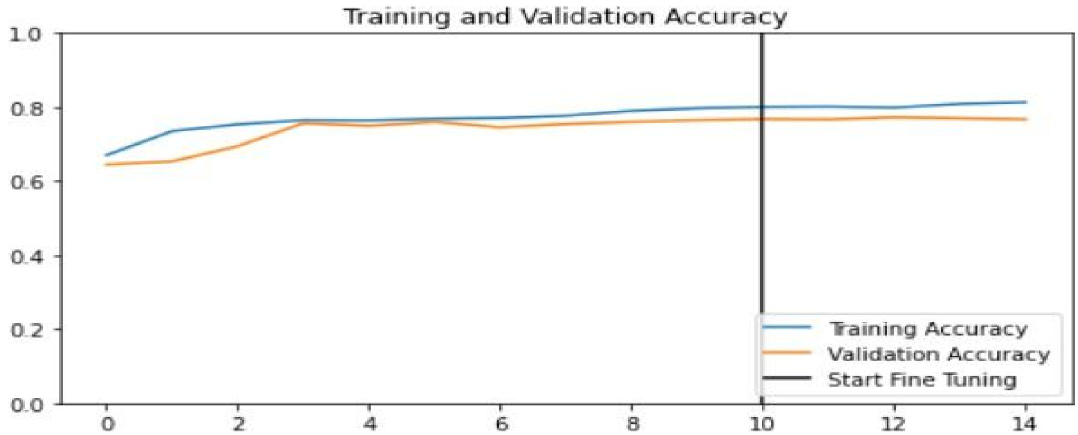
Fully connected layer:

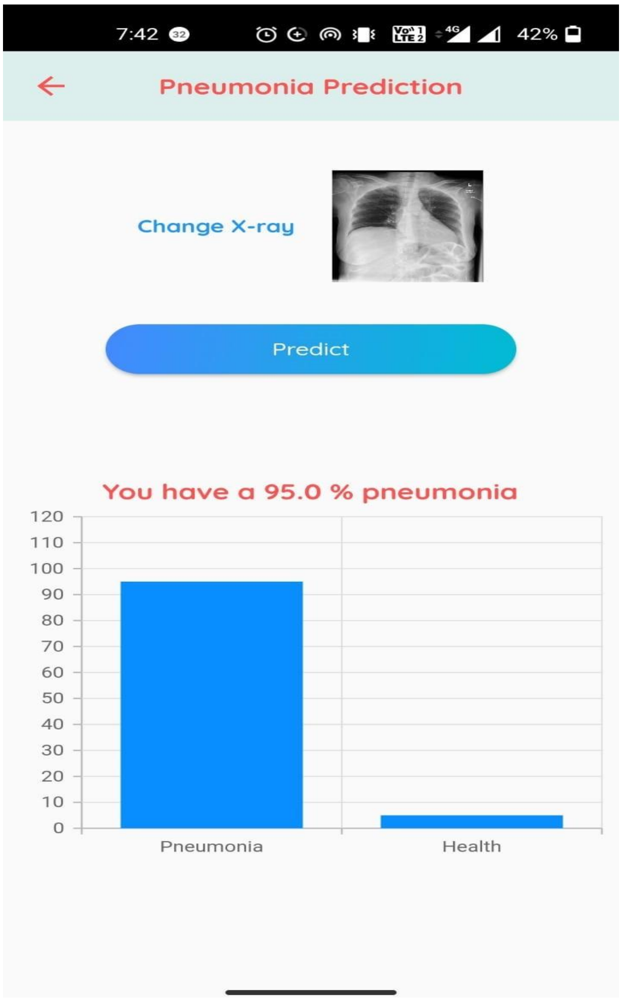
In a convolutional neural network (CNN), a fully connected layer, also known as a dense layer, links every cell in the current layer to every cell in the previous layer. [8]

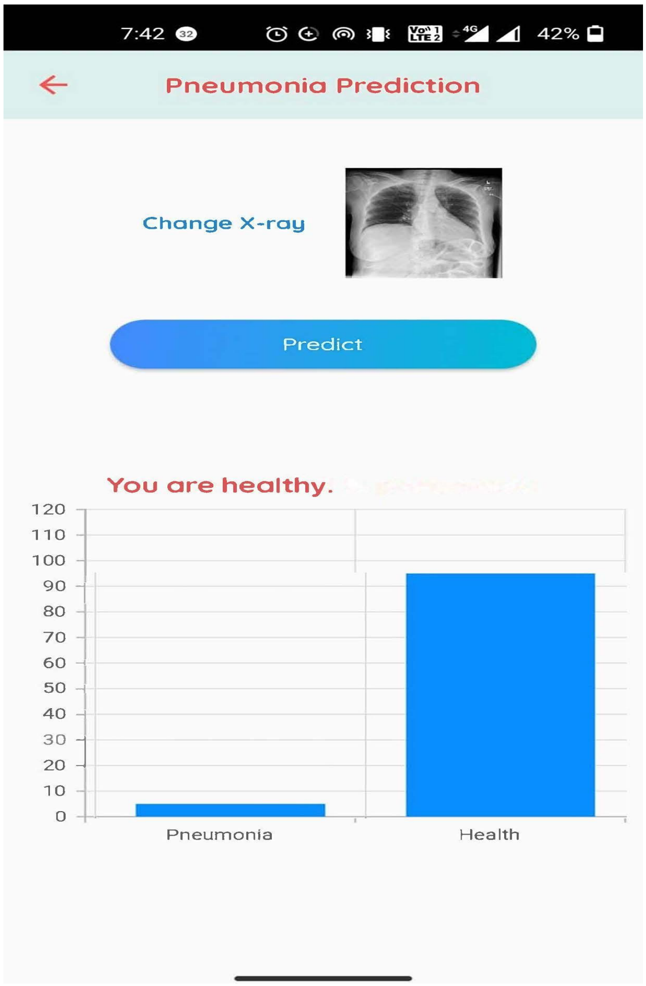


Result:

Validation accuracy, recall, and F1 score were used as performance metrics to examine the effectiveness of each CNN classification algorithm . The accuracy and loss charts were also examined. For each model, the clustering algorithm was also constructed.







Conclusion:

Throughout the process of developing the CNN model for Pneumonia prediction, the researcher has built a model from scratch which consists of 3 layers and follows with a fully connected neural network. Then the trained model is evaluated using separate unnoticed data to avoid bias prediction. The researcher has used 3 layers of CNN to achieve better accuracy compared to any standard machine learning algorithm for predicting pneumonia using chest x-ray images. As a result, the test dataset's average accuracy was 81.25% which suggests a good model.

The researcher demonstrated how to distinguish positive and negative pneumonia data from an X-ray picture collection. We create our model from the ground up, which distinguishes it from other techniques that depend primarily on the transfer learning approach. This research will be expanded in the future to identify and categorize X-ray pictures of lung cancer and pneumonia. Separating X-ray pictures including lung cancer and pneumonia has been a major difficulty in recent years, and our next strategy will address this issue.

References:

[1] Kaushik, V. & Nayyar, Anand & Kataria, Gaurav & Jain, Rachna. "Pneumonia Detection Using Convolutional Neural Networks (CNNs)." Lecture Notes in Networks and Systems, 2020 . 471-483. 10.1007/978-981-15-3369-3_36.

[2] D. Varshni, K. Thakral, L. Agarwal, R. Nijhawan, and A. Mittal, "Pneumonia Detection Using

CNN based Feature Extraction," IEEE International Conference on Electrical, Computer and Communication Technologies (ICECCT), Coimbatore, India, 2019, pp. 1-7, doi: 10.1109/ICECCT.2019.8869364.

[3] Mohammad Farukh Hashmi, Satyarth Katiyar, Abdul Wahab Hashmi & Avinash G. Keskar "Pneumonia detection in chest X-ray images using compound scaled deep learning model", Automatika, 2021, 62:3-4, 397-406, DOI: 10.1080/00051144.2021.1973297.

[4] Patrik Szepesi, László Szilágyi, "Detection of pneumonia using convolutional neural networks and deep learning", Biocybernetics and Biomedical Engineering, Volume 42, Issue 3, 2022, Pages 1012-1022, ISSN 0208-5216.

[5] Kundu Rohit, Das Ritacheta, Geem Zong, Woo Han, Gi-Tae, Sarkar Ram. (2021) "Pneumonia detection in chest X-ray images using an ensemble of deep learning models". PLoS ONE 16(9): e0256630, Volume 16, Month 09, Pages 1-29, 2021.

[6] https://towardsdatascience.com/chest-x-rays-pneumonia-detection-using-convolutional-neural-network-63d6ec2d1dee

[7] https://www.researchgate.net/figure/Figurec-convolution-operation-B-Pooling-Layer-The-main-purpose-of-pooling-layer-is-to_fig2_332570921

[8] https://www.superdatascience.com/blogs/convolutional-neural-networks-cnn-step-4-full-connection

[9] https://en.wikipedia.org/wiki/Pneumonia

[10]https://www.google.com/url?sa=i&url=https%3A%2F%2Fwww.semanticscholar.org%2Fpaper%2FPneumonia-Detection-Using-CNN-based-Feature-Varshni-Thakral%2F2e9bf21eaedf7a18e099d1e0d8faba07d36fc154&psig=AOvVaw19PjrsmLhVjGmO8xYHoahB&ust=1680347071720000&source=images&cd=vfe&ved=0CBAQjRxqFwoTCJjX-qyDhv4CFQAAAAAdAAAAABAE