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Original Article

A New Approach to COVID-19 Detection Using Alexnet from Chest CT Images

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Abstract

Background: At the beginning of 2020, the pneumonia-like COVID-19 virus spread rapidly worldwide. With the emergence of this dangerous virus, work, and daily life have become very difficult. To control this virus, all the centers are closed and quarantined by the government and the countries of the world. Every day, many people from all over the world die due to COVID-19. Many efforts are being made in all fields to diagnose and treat people infected with this virus. For this reason, many researchers started working on identifying this virus and its types. The Scientifics, in computer science, did not sit idle either.

Method: In some studies, different image processing methods and algorithms have been used to extract the edge features of the Computed Tomography (CT) images of the lung. In this clinical-computerized study, lung CT images of non-infected and infected people from different hospitals in Lorestan province were used. This collection has 90 stereotypes of images in jpg format of CT scans of people's lungs, each file has more than 200 images from different angles of lung imaging. The preprocessing methods were the first step of the research. In the second phase, edge detection was applied to the dataset to get the highest accuracy rate. Consequently, a classification Convolutional Neural Network (CNN)-AlexNet architecture was used to reach the final aim.

Results: The results show that the average accuracy rate of image edge extraction with a threshold value of 0.1 is 93% and the accuracy rate of AlexNet architecture classification is 100%. The proposed method helps physicians to improve disease diagnosis from lung CT images to achieve a more accurate detection rate.

Conclusion: This study shows that the CNN-AlexNet architecture effectively increases the diagnosis accuracy rate than the other methods. It is suggested that educational programs for researchers in the field of disease detection from radiology images be provided and that the effectiveness of different types of deep learning methods be compared in future studies.

Keywords: AlexNet; COVID-19 ; Convolutional Neural Network (CNN); Edge Detection Algorithms

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Introduction

At the end of November 2019, a new type of lung disease spread in the city of Wuhan, which covered the whole world. New viruses are always a concern for global public health, and it is possible that technology, by classifying characteristics, can help provide timely treatments more quickly (1). Despite the World Health Organization's emphasis on extensive testing to combat this pandemic, laboratory facilities are still unavailable in many countries (2). Identifying diseases using computers is a continuous process of innovation and creating new solutions to make human life more manageable. CADD aims to find diseases from digital medical images (3). Digital images can be created using various image processing programs in different physical devices such as (X-ray, ultrasonic, cameras, and electron microscopes) and MATLAB is one of the image processing programs used to increase the quality of two-dimensional images (4). It isn't easy to detect COVID-19 from a CT scan of a healthy person. This is done by a specialist doctor (5). X-ray photography, which orthopedic doctors often prescribe, this technology helps people obtain images of damaged areas of the body easily at a low cost. In order to implement a CADD system of human X-ray images, it is necessary to get acquainted with the basic methods of image processing. One of the important stages of pre-processing and digital image processing is edge detection. The main purpose of edge detection is to find points in the image where contrast and brightness change suddenly. In edge detection, the original image is used as the input and output of image edges according to the applied algorithm or techniques. This pre-processing step is very important for the next step of digital image processing. Edge detection is the step before image segmentation to determine and detect features or regions (ROI). It should be done with high accuracy, minimum noise, and in the shortest time possible to get the desired output. Covid-19 is an emerging virus that is currently not very easy to diagnose with high accuracy. In Figure 1, you can see the lung damage, which spreads daily due to the virus infection.

Figure 1. Lung injuries

These injuries can be found by specialized doctors or trained machines using tomography. Laplacian filter for edge detection by which prominent edges are detected. These edges may contain blood vessels and extend the shape of damaged cells. A laplace filter is a method that shows the difference in appearance and advanced edge extraction. (6). Canny is one of the edge detection algorithms. Traditional gradient-based edge detection algorithms such as Roberts, Prewitt, and Sobel are sensitive to noise positions and do not have sharp edges. Laplacian algorithms can extract false edges and large focusing errors at a particular point in rounded edges, which is actually one of the disadvantages of this algorithm. The Canny algorithm proposed an improved edge detection method that reduces false edge detection. The Canny algorithm also correctly detects sharp edges. Also, the old edge detection with a Canny algorithm also has some shortcomings. One of its disadvantages is that even if the Gaussian filter removes the noise, important edges are also lost or smoothed. This causes the edges to weaken and the false edge to increase. X-ray is a type of radiation called electromagnetic waves that are used in medical imaging. In this type of imaging, an area of the person's body is placed in front of a small dose of ionizing radiation; thus, images are taken from inside the body. In this study, we present an advanced edge detection technique with the Canny algorithm (7). Therefore, using deep learning techniques, edge detection, and thresholding algorithms on lung CT-scan images, it is possible to improve the clarity of the radiology images of the affected person. This article suggests image edge detection with Sobel and Canny filters, with the highest accuracy rate, and classification of images using the CNN method. To help the doctor in the simple and timely diagnosis of the radiological image of a person suffering from COVID-19. If the diagnosis of the radiological image is accurate and timely, the treatment and control of the affected person will be more effective.

Hamadan et al. (8) used deep learning methods to discover the positive or negative result of the COVID-19 test. They announced that the vgg19 model improved with 90% accuracy on 25 images infected with COVID-19 and 25 not infected with COVID-19. Ergen et al. (9) placed 295 images of people with COVID-19, 98 images of pneumonia, and 65 images of healthy people in mobile net and squeeze net. They discovered the features from the trained network samples and used the SMO algorithm for feature selection, with an overall accuracy of 99.27%, and for the SVM classifier. Zhou et al. (10) studied an 18-layer ResNet model on 100 images of people with COVID-19 and 1431 people with pneumonia and finally announced the survey result with an accuracy of 95.18%. The vgg19 model has been trained by Apostolopoulos and Mpesiana (11) on 224 images of patients with COVID-19, 700 patients with pneumonia, and 504 images of healthy individuals, with results showing an accuracy of 98.75%. Biswas and Hazra (12) have presented a modified moore neighbor edge detection model. This algorithm consists of two steps: the first is to modify the neighborhood more algorithm, and the second is to apply a range filter to extract the edges. Calculating the edges takes time. Agrawal and Desai (13) presented an edge detection model based on the Canny comparative method, which has more advantages than the global threshold method. The Sobel edge detection algorithm has been designed to increase the edge detection angle. It has enough slope measurement to increase the extraction accuracy and detect more edges in the image. The WL operator was invented by Lin and Wang (14) as an edge finder based on mathematical form. This operator is efficient in the edge detection of medical images. Nowadays, image processing with MATLAB in medical use is very important. The Matlab software allows you to perform computer graphics and image processing tasks. The features of this software are analysis, powerful graphics, and programming capabilities. The image processing algorithms evaluate a pixel's values as an output from all the received data (15). Many researchers emphasize the necessity of image data in medicine as important data and believe that although the processing of digital medical images is expensive, it will always achieve better results by reducing the noise and increasing the image quality. Processed medical images contain a lot of information and features about a specific disease. Algorithms in the MATLAB program provide this image analysis and recognition. Currently, MATLAB is a suitable computing platform and an important pillar in visual communication, and it is used to develop and test some programs. The authors proposed learning about the MATLAB program in digital signal processing. According to the authors, MATLAB software has a graphical user interface that increases learning and working with commands. MATLAB software has various image processing concepts and techniques, such as edge detection, image enhancement, segmentation, and noise removal. The authors recommend the MATLAB digital image processing program, which includes commands for character recognition and feature discovery, as well as remote sensing and computer vision. The image segmentation technique is presented in MATLAB software. Image segmentation is one of the essential steps in the analysis, object representation, and image visualization to transform an image into an image with better quality.

MATLAB software has different techniques for dividing the images and analyzing their outputs. Image processing shows the necessity of analysis in biomedical imaging and disease diagnosis. Ultrasound, MRI, and CT scanners are examples of medical equipment that use image processing techniques and algorithms. Radiologists use image-processing algorithms to diagnose certain diseases and disorders. According to the author, the image processing algorithms in MATLAB software aim to improve efficiency, accuracy, flexibility, and reduce time constraints. MATLAB, Scilab, and Raspberry Pi software were investigated for image processing; the authors proposed MATLAB, Scilab, and Raspberry Pi image processing software for edge detection techniques to determine the edges of objects in images, image segmentation, and feature extraction. In image processing, edge detection is important for feature detection (16). Their method for image processing was image acquisition, segmentation, feature discovery, and classification. An important step in the image processing process is edge detection, which applies the image processing process to an image using several operators. The efficiency of each of the different edge detection algorithms and operators (such as Sobel, Robert, Prewitt, Connie, and Laplacian Gaussian) has also been discussed (17). Edge extraction is a mainstay for several image processing techniques and processes, such as image development, tracking, segmentation, and encryption. One of the important steps in image processing algorithms is image segmentation, where the hard and complex parts of the image are used for image processing. COVID-19 should be diagnosed accurately and quickly without any deaths because it can have a significant impact on the country's economy and the health of the country's people. People suspected of having COVID-19 should get a chest X-ray. X-ray image recognition by humans often faces various visual errors that play a significant role in diagnosing patients.

As a result, a computer mechanism can help doctors in the accurate and appropriate analysis of the image of the lungs of a person suffering from COVID-19. These mechanisms can often be useful solutions and programs in less developed or developing countries, which have large numbers of patients and lack facilities and conditions for medical care. The authors of image processing algorithms have been investigated in diagnosing X-ray images of bone fractures. They have used edge detection and image segmentation methods to simplify the detection mechanism. These mechanisms will reduce the processing time.

Although image processing has been used in various medical studies, it is still in its infancy in studies conducted in the field of COVID-19 diagnosis. Artificial intelligence has been applied in all fields, such as image classification, big data analysis, and disease diagnosis. Its approaches have been widely used to accelerate the progress of medical research and biological structure. ML, DL, and PR approaches focus on finding solutions and making optimal decisions regarding current and forced problems. Data is pre-processed, segmented, trained, and tested in such systems. Then, new data can be segmented. Specifically, in a training step, the received data is pre-processed. Then, special features are discovered (18).

So, when working on X-ray images, we should consider reducing the number of accidental noises that occur during imaging and reducing image quality and errors in diagnosis. Therefore, researchers propose using a time-recursive filter and an improved technique in such cases. Other image preprocessing algorithms include adaptive histogram equalization, adaptive contrast expansion, and histogram smoothing. Sometimes, when saving images, there is a lot of noise due to shaking or moving the device and imaging equipment. But in most cases, X-ray images show more noises, such as Gaussian noise, Salt, and Pepper. According to the investigations, the median algorithm has been used to solve this problem and reduce image noise. Chest X-ray images can be used to diagnose lung infections. Researchers use the CNN method to classify real and fake X-ray images (19). Salient features discovered from lung X-ray images develop classification efficiency. This method performs optimally when a lot of data is entered as input. Deep learning algorithms are used to analyze the chest X-ray image in such cases. Pneumonia can be easily diagnosed by using an X-ray image. This is an advanced method to identify people with corona. The authors are very optimistic about using artificial intelligence to timely identify people with Covid-19. Learning algorithms classify datasets of people with normal or abnormal lung infections. Labeling this data helps the implementation of this method to minimize errors. The CNN method is trained with a set of unconnected data. Researchers have presented a new architecture of deep learning to identify lung diseases. The authors have used the most common deep learning method, transfer learning, for better classification performance. The features in the ImageNet have been previously trained and discovered.

With the help of the classification model, it is possible to guess whether a person has pneumonia. This advanced method showed an accuracy rate of 96.4%. In new studies, researchers have designed a deep neural network to determine the difference between lung infections caused by COVID-19 and other lung infections caused by viruses from chest X-ray images. Researchers have proposed an automatic screening system for the identification of COVID-19 that uses radiomic pattern descriptors to clean CXR images to identify normal patients or patients with similar symptoms of COVID-19 (20). Researchers have guessed the severity of the COVID-19 virus from chest X-ray images. This method effectively determines the amount of pneumonia in the control and treatment of patients in the intensive care unit. Sharma et al. The transfer learning method has been used to classify respiratory diseases such as lung infections, tuberculosis, and COVID-19 or identify the lungs of healthy people. For this reason, during the new investigations, image pre-processing techniques, algorithms, and deep learning methods have been designed and proposed to identify respiratory patients. Photos of COVID-19 were discovered in the public database and used for further processing. 78% of the COVID-19 X-rays are randomly parsed into the training dataset to learn the classification, and 22% of the COVID-19 X-rays are used for authentication. The lung region in the photos of the training dataset is physically segmented to learn the machine learning model to finally segment the lungs from the X-rays of the lungs of COVID-19 (21). Similarly, a total of 1200 photos containing normal and pneumonia (learning and testing) were used for the proposed method and are shown in **Table 1**.

Table 1. A sample of the Dataset for designing

Chest X-ray image	Number of images used for training the model	Number of images used for testing the model
Normal Lung	110	30
COVID-19	110	30
Pneumonia	110	30

Similarly, the sample dataset is shown in **Figure 2**. **Figure S1** shows the preprocessing flow of the COVID-19 images and the detection of lungs through the sliding window method. **Figure S2** hows the pre-processed (contrast) photos.

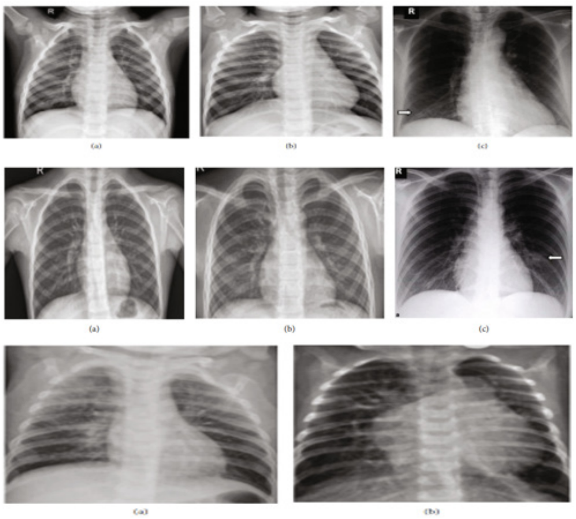

Figure 2. 1) Sample image from the training dataset: (a) normal; (b) pneumonia; c) Covid-19; **2)** Sample image from test dataset: (a) normal; (b) pneumonia; c) Covid-19; **3)** Sample image from validated data set: (a) normal; (b) pneumonia

Materials and Methods

Edges contain meaningful and describable data and features. By running the edge detection algorithm on an image, the amount of data and important features for processing can be reduced, and irrelevant data can be filtered. In this review, it is suspected that lungs with pulmonary disorders contain more abnormal edges than healthy lungs. These features help distinguish the pulmonary condition. This part discusses two Sobel and Canny algorithms for edge detection with different threshold values and their comparison, convolutional neural networks with AlexNet architecture for classification of lung images of people with COVID-19 and non-infected people. In the following, the performance of the proposed Sobel and Canny algorithms and convolutional neural networks with AlexNet architecture is explained in detail. Estimation of the intensity gradient at a pixel in the x and y direction for an image f is given by **Equation 1:**

$$\frac{\partial f}{\partial x} = f(x+1, y) - f(x-1, y)$$
$$\frac{\partial f}{\partial y} = f(x, y+1) - f(x, y-1) \qquad (1)$$

The gradient calculation (g_x, g_y) can be expressed as:

$g_x = h\,x * f(x, y)$
$g_y = h\,y * f(x, y)$

Sobel algorithm

The Sobel algorithm is such that this filter finds edges using derivative estimation. The Sobel filter has two masks: the horizontal Sobel mask defines most of the horizontal edges, and the vertical Sobel mask defines the vertical edges. A value is also provided for the threshold. An algorithm is a finite set of instructions that are executed in a specific order to process a problem. An algorithm for edge detection from X-ray images is developed and presented here. If we define Gx and Gy as two images that contain the horizontal and vertical derivative approximations, respectively, the computations are performed by **Equation 2:**

$$G_x = \begin{pmatrix} 1 & 0 & -1 \\ 2 & 0 & -2 \\ 1 & 0 & -1 \end{pmatrix} * A \quad \text{and} \quad G_y = \begin{pmatrix} -1 & -2 & -1 \\ 0 & 0 & 0 \\ 1 & 2 & 1 \end{pmatrix} * A \qquad (2)$$

Where A is the original source image.
The x coordinate is defined as increasing in the right direction, and the y coordinate is defined as increasing in the down direction.
At each pixel in the image, the gradient approximations given by Gx and Gy are combined to give the gradient magnitude, using:

$$G = \sqrt{G_x^2 + G_y^2}$$

The gradient's direction is calculated using:

$$\Theta = \arctan\left(\frac{G_y}{G_x}\right)$$

A Θ value of 0 would indicate a darker vertical edge on the left side.

Algorithm: Extraction or edge detection from X-ray images and their classification
Step 1: Enter an X-ray image as input
Step 2: Apply Sobel, Canny filter on input image with different thresholds.
Step 3: The output of edge-detected images is obtained.
Step 4: The output of the previous step is used as the input of the CNN machine.

In the first step, the user enters an X-ray image. The second step is to apply Sobel and Canny filters with different threshold values for image edge detection. In the end, it shows the X-ray image output with edge extraction. The third step is the output of edge-detected images. In the fourth step, the output of the previous step is used as the input of the CNN machine.
In this paper, a model for the screening of COVID-19 according to CT scan images is presented. The AlexNet architecture was developed for this purpose, and the models were trained with CT images from non-infected and infected Sar-Cov-2 subjects.

Canny algorithm

In this method, the Canny algorithm is also used for thresholding to find weak and strong edges, including only weak edges in the output connected to strong edges. This method is more about detecting weak edges correctly, is less fooled by noise, and is better than other methods. Canny has shown that the first derivative of the Gaussian closely approximates the operator that optimizes the product of signal-to-noise ratio (SNR) and localization, as can be seen in **Equation 3**.
Algorithm:
1. Compute fx and fy

$$f_x = \frac{\partial}{\partial x}(f * G) = f * \frac{\partial}{\partial x} G = f * G_x$$
$$f_y = \frac{\partial}{\partial y}(f * G) = f * \frac{\partial}{\partial y} G = f * G_y \qquad (3)$$

G(x, y) is the Gaussian function.

$G_x(x,y)$ is the derivate of G (x,y) with respect to x: $G_x(x,y) = \frac{-X}{\sigma^2} G(x,y)$

$G_y(x,y)$ is the derivate of G (x,y) with respect to y: $G_y(x,y) = \frac{-y}{\sigma^2} G(x,y)$

2. Compute the gradient magnitude

$$\text{magn}(i,j) = \sqrt{f_x^2 + f_y^2}$$

3. Apply non-maxima suppression
4. Apply hysteresis thresholding/edge linkin

Convolutional neural networks (CNN)

A special kind of deep learning method is CNN, and it is used in processing and analyzing images (22, 23). It is a learning architecture based on deep neural networks used for processing big data (24). This algorithm was first used in 1960. Convolutional neural networks (CNN) are one of the most important deep learning methods trained in powerful ways. This method is widely used and is among the most common methods in various computer vision applications. In general, a CNN consists of three basic layers: the convolution layer, the pooling layer, and the fully connected layer. Different layers perform different tasks. In each convolutional neural network, there are two training steps. In the first step, the input image is given to the network, and this operation is nothing but a point multiplication between the input and the components of each neuron, and finally, the convolution operation in each layer. Then, the output of the network is evaluated. In the next step, the backpropagation step starts based on the calculated error size. In this step, the gradient of each component is evaluated.

According to the chain rule, all parameters are changed according to their effect on the error generated in the network. After updating the components, the next step of feed-forward starts. After several stages, the appropriate number of repetitions of these stages of training the network is terminated.

Types of CNN Network Layers

At each level, the CNN neural network learns to recognize images. In general, a CNN network is a hierarchical neural network whose convolutional layers are one in the middle with integration layers. After them, there are a number of completely connected layers. The AlexNet architecture is used in this article. **Figure 4** shows the CNN architecture.

AlexNet architecture

In 2012, AlexNet was introduced as a neural network. With the recent developments in using CNN in the field of computer vision, well-known models of convolutional neural networks were created. AlexNet is a valuable convolutional neural network architecture with five and three fully connected layers. This architecture receives 3*224*224 photos as input, then processes the input photo by performing successive convolution and pooling operations, and finally sends the result to fully connected layers. This network is trained on the ImageNet data set and uses different regularization methods, such as data augmentation, dropout, etc. Has been used. The main problem of this architecture is that images with fixed sizes should be used. This study used two sets of edge-detected files containing 30 images of healthy lungs and 30 images of COVID-19 with size 227*227 and jpg format for training.

Presenting an attitude with four steps, which are explained in parts A to D of each step (24).

A. Two data sets are used in this study. Chest images of people with COVID-19 and non-infected images. To prevent class inconsistency, 30 identical images were prepared from the output of the extracted edge of the lungs of people with COVID-19 and healthy lungs.

B. Image processing is a computer mathematical process expressed in a two-dimensional image. In general, image processing has the following three steps, which block diagram is shown in **Figure S2**.

Receiving an image means entering a photo using a device such as an optical scanner or a digital camera.

Image analysis and manipulation Image

Image analysis result output.

Three stages of image processing were done using the proposed method. In the first place, the CT scan images of the lungs of people with and without COVID-19 were imported. In the second step, edge detection was applied with algorithms (Sobel & Canny) with different image threshold values. The last step is receiving images of the CT scan of the edge of the lung.

C. There are many CNN designs in use. CNN design model named AlexNet was used in this study. The sets were divided into training and validation data. 30% of the images from each set were selected for training data, and the rest, 70%, were selected for validation data. To avoid biasing the result to fully connected layers. This network is trained on the ImageNet data set and uses different regularization methods, such as data augmentation, dropout, etc. Has been used. The main problem of this architecture is that images with fixed sizes should be used. This study used two sets of edge-detected files containing 30 images of healthy lungs and 30 images of COVID-19 with size 227*227 and jpg format for training.

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D. In machine learning, a set or category is used for more than one sample to make predictions. This category often minimizes prediction variance and is able to make predictions that are more accurate than any other sample. In this paper, the set or category was made in the middle of the assumed superiority of each sample. Consider that p is the superiority guess, c is a classifier, and n is the number of classifiers, then the final label is evaluated as **Equation 4**. When predicting the label of a new image, a pattern creates a hypothetical advantage. By averaging the probability scores of several samples, the final label of the image is determined (24).

$$final\ lable = \frac{\sum_{1}^{n} p(c1)+p(c2)+\cdots+p(cn)}{n} \quad (4)$$

Data collection

A set of lung CT images of non-infected and infected people from hospitals in Lorestan province has been used to test the proposed method. This collection has 90 stereotypical images in jpg format of CT scans of people's lungs, and each file has more than 200 images from different angles of lung imaging. As shown in **Table 2**, 200 CT scan images of healthy and diseased lungs have been used for edge detection. Finally, 30 images of these edge-detected images have been used for model training and testing. Alexnet model: It is possible to teach with 10 images. In this study, as an example, 30 images were used to classify images using the Alexnet model. This number is variable.

Results

After applying the proposed algorithms to the photos, two images are displayed in the output, including the lung's initial CT scan image and the lung's edge-detected image by edge detection filters with different threshold values. In the next step, the features extracted from the CT scan images of the lungs of healthy and COVID-19 patients were collected as classifier inputs, and using the AlexNet model, these images were classified. In this way, the accuracy percentage of edge detection of CT scan images with different thresholds was also compared, and the highest average threshold value was 0.1.

Table 2. Used data sets for edge detection

CT Scan Images	The Number of images used for edge detection	The number of images used to train the model	The number of images used to test the model
Healthy lung	200	30	**30**
Lung infected with COVID-19	200	30	**30**

The classification of these images with the pre-trained learning model of the AlexNet was reported as 100%. The proposed method for detecting the edges of CT scan lung images of healthy and COVID-19 patients has the following steps:

1. Get an X-ray image as input
2. Applying Sobel and Canny filters by setting threshold values on the input image
3. Edge-detected X-ray image output
4. Classification of the previous stage images by machine
5. Healthy diagnosis or having Covid-19

Figure 3 shows the proposed method, and **Figure 4** shows edge detection with different threshold values.

As you can see in output image 10, the output includes an initial CT scan image of the lung and its edge-detected output with different threshold values of 0.1, 0.2, and 0.3. To calculate the accuracy rate of the ratio of the number of correctly classified samples to all samples, as **Equation 5** shows (NT: The number of correctly identified Samples. ; N: The total number of samples.)

$$Accuracy = N_T / N$$

Table 3 shows the percentage of accuracy of edge detection in CT scan lung infected images.

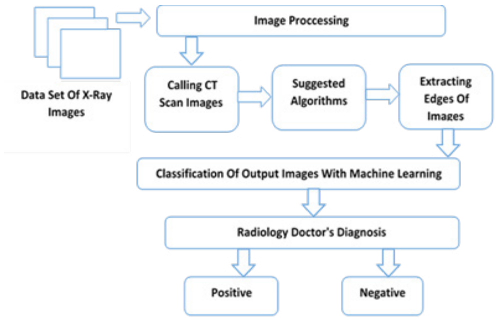

Figure 3. Proposed method flowchart

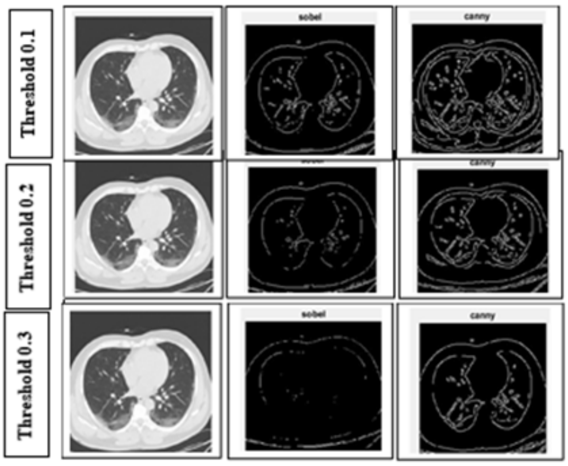

Figure 4. The initial CT-scan image and the edge-detected image by applying Sobel and Canny filters with different threshold values

Table 3. Evaluating the accuracy of image edge detection

Edge detection method/threshold	N	N_T	Accuracy rate
Sobel / 0.1	200	180	90%
Canny / 0.1	200	190	95%
Sobel / 0.2	200	60	30%
Canny / 0.2	200	200	100%
Sobel / 0.3	200	90	45%
Canny / 0.3	200	200	100%
The average accuracy rate of the Sobel filter			55%
The average accuracy rate of the Canny filter			98%

Figure 5 compares the accuracy percentage of edge detection of images by applying Sobel and Canny filters with different threshold values.

Table 4 shows the accuracy results of the comparison between two methods of edge detection in different thresholds. **Figure 6** compares the edge detection accuracy rates of Canny and Sobel algorithms by different threshold values. As can be seen in **Figure 7**, after three different values of initial learning rate, the accuracy rate has been increased. After storing the edge-detected images from the lung CT scans of healthy and infected people, a data set was prepared, which includes two classes of infected and non-infected people. Then, for testing, the AlexNet model was trained with different values, and **Table 5** shows the learning rate of the initial with different values. **Figure 8** and **Figure 9** show the output of the AlexNet model CNN classification machine and its accuracy chart with 100% classification accuracy.

After applying the algorithms proposed by Sobel and Canny to the photos, two images are displayed in the output, which includes the initial image of the CT scan of the lung and the edge-detected image of the lung by edge-detection filters with different threshold values. In the next step, the edge-detected images of infected and non-infected people were collected for classification, and these images were classified using the AlexNet model.

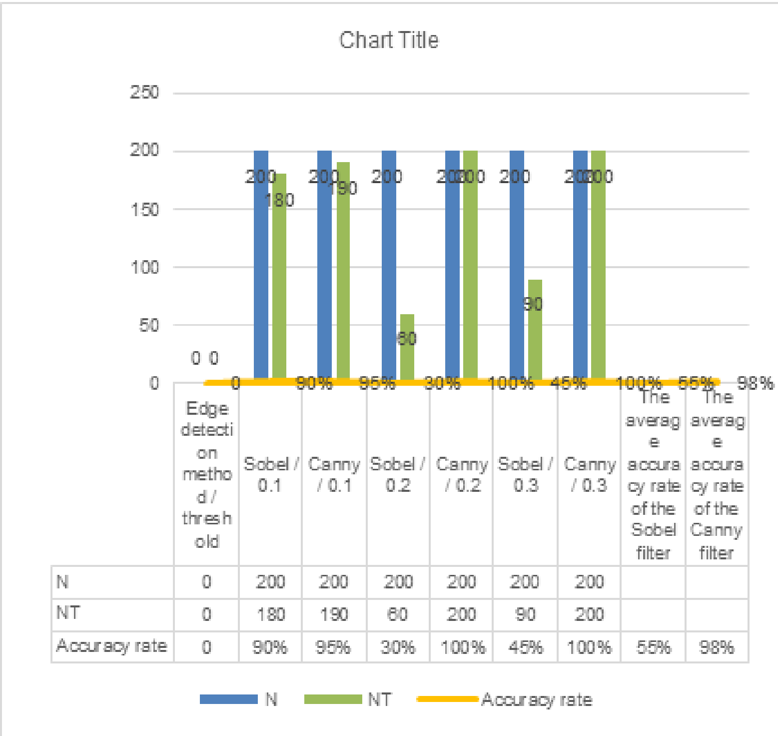

Figure 5. Comparison of Sobel and Canny filters with different threshold values.

Table 4. Comparison of edge detection accuracy rate by different thresholds

Proposed methods	N	N_T			Edge detection accuracy rate 1%	Edge detection accuracy rate 2%	Edge detection accuracy rate 3%
		Threshold 0.1	Threshold 0.2	Threshold 0.3			
Edge detection by Sobel	200	180	60	90	%90	%30	%45
Edge detection by Canny	200	190	200	200	%95	%100	%100
Average threshold values					%93	%65	%73

Figure 6. Different values of initial learning rate

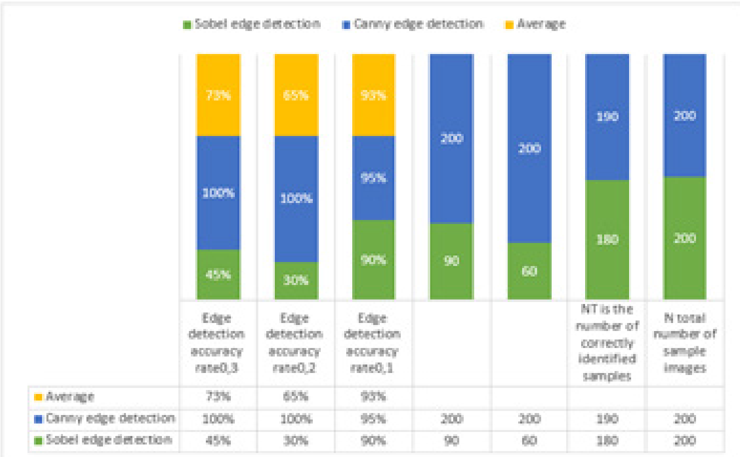

Figure 7. Comparison of edge detection accuracy rate with different thresholds

Table 5. Initial learning rate

AlexNet architecture	Initial Learning Rate			The number of CT scan images of healthy people's lungs	The number of lung CT scan images of people with COVID-19
	0.01	0.0001	0.0003		
Classification accuracy	50%	83.33%	100%	30	30

Discussion

Recognizing respiratory diseases in the early stages of the disease and based on chest X-ray images leads to health and well-being. Today's development of technology has encouraged people to do research work in the field of image-processing techniques (25-28). Among recent technologies, image processing techniques are expanding rapidly. These techniques include applying algorithms to images to increase image quality or discover useful and efficient features from the image. One of the image processing techniques is to discover the features on the edges of the images. It seems logical to perform edge detection before image interpretation in automatic systems. Performing edge detection is an important process

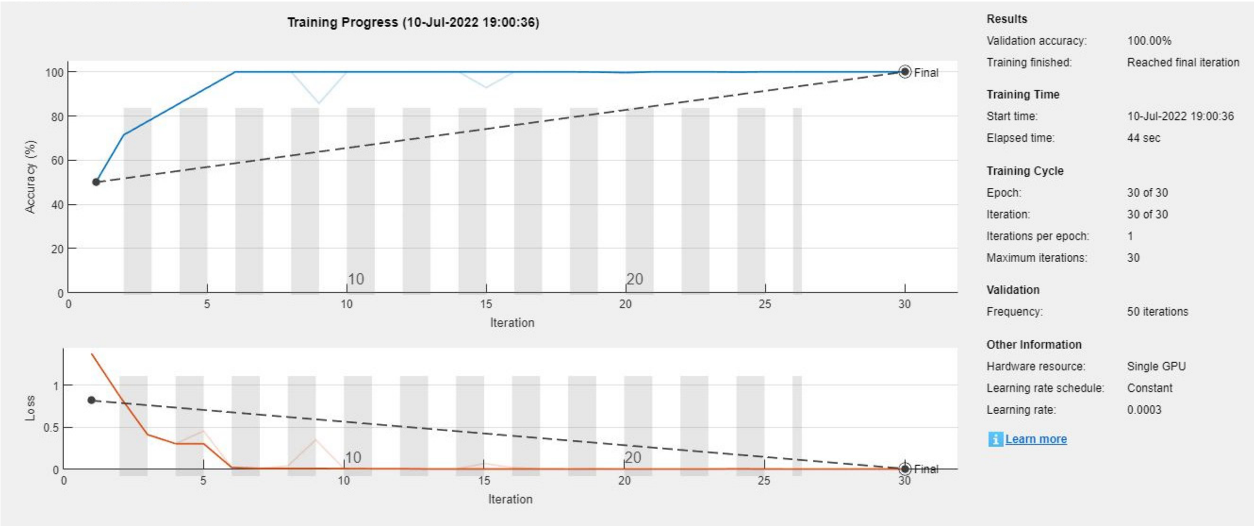

Figure 8. Accuracy chart of AlexNet classification model

Figure 9. The healthy and sick people classes

in many artificial vision systems.

The main goal of edge detection is to reduce the amount of data in the image while preserving the original image structure and shape. Edge detection is crucial because it simplifies the image data while preserving the essential structural elements. Reducing unnecessary details makes it easier to analyze, interpret, and recognize patterns in an image. But it should be kept in mind that in the edge detection process, higher accuracy is too important (29). Therefore, testing different algorithms and threshold values on images is better. The edge can be considered as the place where the horizontal and vertical planes of the object meet. One of the most common applications in image analysis is edge detection because the edge is the boundary between an object and its background. In other words, the edge is the change of two gray levels or values related to the brightness of two adjacent pixels in a certain place of the image. The greater the change in level, the easier it will be to detect the edge. The points of the image that have sudden brightness changes are often called edges or edge points. Edge points usually include object boundaries and other types of lighting changes, as well as noise edges. Therefore, edge detection algorithms are used to discover and extract important features of images. Edges are a possibility for extracting important features of digital images. There are different ways to detect the edges of images.

After the preprocessing phase, the learning methods can come to the war scene. Deep learning methods have emerged in this field, and many researchers have used these approaches in their studies. In the meantime, CNN and its architecture have shone brightly (30-34).

The proposed method uses lung CT images of healthy and patient people from some hospitals in Lorestan province. This dataset has 90 stereotypes of CT lung images in jpg format, and each file has more than 200 images from different angles of the lung. In the edge detection step, 2200 CT images of healthy and diseased lungs were used. After the edge detection phase, the model creation was started. The alexnet model was selected to classify data. The proposed method was implemented using MATLAB software and edge detection algorithms.

In short, at the first step, an X-ray image is entered. In the second phase, the Sobel and Canny are used with different threshold values. The results showed that the Canny method gives better results than the Sobel in different thresholds. It can also be seen that the accuracy rate has increased after three different values of the initial learning rate.

Next, the X-ray image is obtained with edge extraction. The outputs of the previous step are used as input for the CNN model by AlexNet architecture. The proposed method for detecting the edges of CT scan lung images of healthy and COVID-19 patients has two classes as CNN output.

The accuracy rate of edge detection in CT images by different thresholds was also compared, and the highest average threshold value was 0.1. The classification of these images with the pre-trained learning model of the AlexNet was reported as 100%. The results show that the accuracy rate increased and the loss rate decreased in training progress.

Conclusion

One of the most important problems faced by radiologists is diagnosing and identifying the COVID-19 virus from CT scan images of the lungs of healthy and infected people. Because there are people with other infectious lung diseases whose diseases are misdiagnosed, this issue delays the management of the patient's condition, which will be irreparable in some cases. Because early detection of healthy people infected with the COVID-19 virus is important, one of the significant roles in managing and controlling this disease is accurate and timely identification. Researchers and computer science experts have taken many measures to provide different methods of identifying this virus, and various algorithms have also been provided. The purpose of this article is to improve and diagnose the disease of the COVID-19 virus from the images of CT scans of the lungs of healthy and infected people. In the proposed method of the article, Sobel and Canny edge detector filters have been applied to the primary CT scan images of the lung, which is superior in terms of the accuracy percentage of the edge detector algorithms to easily edge detection. Then, the set of output images is classified into two classes of healthy and diseased people by one of the machine learning algorithms named CNN-AlexNet. The output of the classification machine was 100%, and the highest average accuracy rate of image edge extraction with a threshold value of 0.1 times 93% was reported.

Data Availability Statement

The data are not publicly available due to restrictions that the hospital has created for authors because they contain information that could compromise patients' privacy.

Conflict of Interest

The Authors declare that they have no conflict of interest.

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