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An Effective Feature Extraction Technique for COVID-19 Detection

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Abstract

This research conducted a survey of the methodologies and varieties of feature extraction. This study shows that a variety of visual attributes can be retrieved and are useful for producing accurate results. The major goal of this project is to design and develop an efficient feature extraction technique for COVID-19 disease diagnosis. This research paper delves with partial implementation of Covid-19 detection. Here, the processing steps include pre-processing, lung lobe segmentation, extraction of lung region using CNN and COVID-19 detection. Initially the pre-processing of irrelevant noises are removed on the input Chest X-ray images with median filtering and then performed Region of Interest(ROI) extraction process. The segmentation of lung lobes from the images is done using the U-net model. Using CNN features affected lung lobe is separated. In this paper the focus is more on image feature types and feature extraction methods and finally have implemented CNN feature extraction method on COVID-19 Image.

Keywords: Feature extraction,preprocessing, segmentation,Unet model

Introduction

For multimedia processing, feature extraction and representation are essential steps. Therefore, this paper's analysis of recent developments in image feature extraction and comprehensive survey of image feature representation techniques are its main foci. [1]. This paper concludes with a partially implemented Covid-19 detection. The goal of feature extraction is to establish more features from training data. This study describes a method for

assessing the effects of autonomous feature distribution and extraction in deep learning applications using convolutional neural networks (CNN) [2].

In order to diagnose COVID-19, symptoms like fever, coughing, and headaches may emerge one to 14 days after virus contact. Reverse transcriptase inReal Time reverse transcriptase Polymerase Chain Reaction (RT-PCR) has been utilised for regular screening. Additionally, chest radiological scans like Computed Tomography (CT) and X-rays can aid with diagnosis of COVID-19 patients who have a severe infection[3].

This study's main objective is to design and construct a trustworthy system for COVID-19 detection. Pre-processing, lung lobe segmentation, lung region extraction, and COVID-19 detection are the processing steps in this case for COVID-19 detection. Utilizing median filtering and the RoI extraction procedure, the irrelevant noise in input Chest X-Rays are pre-processed. Using the U-net model lung lobes are separated from images. The damaged lung region is then isolated from the lobe using CNN characteristics, which are then partially implemented and explained in this work along with the findings[4].

The remaining section of this paper is explained in the following manner. Section 2 describes the Dataset Description, section 3 describes the Background Technology, section 4 Methodology and section 5 portrays the results and discussion of the model and section 6 explains the conclusion of this paper.

Literature Review

This section presents a review of the literature based on various COVID-19 prediction methods based on Chest X-Ray images that are currently in use. K.Shankar and Eswaranperumal [5] created a unique deep learning-based fusion approach for CXR images to detect and classify the COVID-19 disease. Here, feature extraction ,feature classification were carried out using a fusion model, where fusion model was obtained by merging Local Binary Pattern (LBP) with features of Deep CNN. The pre-processing method used Gaussian filtering. Even though this method's training requirements were minimal, it failed to make use of other effective categories for enhanced performance. Aras M. Ismael and Abdulkadir Engür are working to address this. In order to recognise the COVID-19 disease while using less memory, Pratik Autee et al. [6] created a Multi-Layer Perceptron (MLP) with stacked

ensembling strategy. Here, the U-net model was used to partition the lungs, which allowed for faster classification. This strategy improved accuracy and decreased the percentage of false negatives, but it needed additional training time. AsifIqbal Khan et al. [7] created the Deep CoroNet model for detecting and diagnosing the COVID-19 infection using CXR images in order to avoid misclassification. The Deep CNN model was used in this case to find the illness. Although the developed technique had a higher level of classification accuracy, it had not been tested using optimization methods. Nevertheless, this approach used a lot of RAM. Along with Junaid Latief Shahb[8], Asif Iqbal Khana The COVID-19 disease was identified using the CoroNet model. Here, disease detection was accomplished using CXR pictures and other publically accessible datasets that contained COVID-19 disease data. However, this approach was only successful when additional information was used.

Data Set Description

For this work, chest X-ray pictures were used to partially implement COVID 19 detection using the DeepCovid dataset. Approximately 5000 pictures and their binary labels make up this dataset. where the dataset is produced from two sources from GITHUB and Kaggle. Choosing the anterior-posterior images will help diagnose Covid-19 illness. Additionally, anterior-posterior CXR pictures devoid of even the tiniest COVID-19 indicators are removed from the dataset. The following information was used to generate the Covid-Chest X-ray-Dataset for COVID-19 X-ray samples and the ChexPert Dataset for non-COVID samples[4].

Back Ground Technology

One important method for processing a image is image restoration. Image restoration is the technique of taking a noisy image as an input and producing the clear, original image. Every field where images need to be comprehended and studied uses this method. The primary goal of restoration techniques to improve the quality of the images[9].

Data Preprocessing : Image processing is a crucial step in obtaining accurate classification and relevant information by removing noisy or distorted pixels from each image. To prepare the images for system input, they must first be resized to 224 x 224 pixels[10].

In the pre-processing step, ROI extraction, median filtering process is carried out to remove the irrelevant noises and distortions from the image. The purpose of

the pre-processing phase is to increase the COVID-19 detection's effectiveness. The median filtering is first applied to the input image in the prep-processing stage, and the ROI extraction is then applied to the median filtering's output.

Median filtering: First, the median of the pixel's intensity levels is determined. The median, or midway, of the pixel values, for instance, will be 5 if they range from 1 to 9. The damaged pixel value is substituted for the new value following the median calculation. Because it only impacts one pixel in the area, the median value is never affected. This filter is stronger as a result. This filter outperforms all others in terms of maintaining crisp edges[9][11][12]. What are the benefits of median filters? The median filter addresses the issues of the mean filter. Preserve the clarit, tiny details, and thin line edges of an input image[13][14].

ROI extraction:

The region of interest (ROI) was extracted for training and testing in order to remove extraneous text and machine annotations surrounding images. The ROI on the chest X-ray images was established by an area primarily including the lung region in order to acquire useful information. An ROI is first defined by a rectangle, which is then used to make a mask. The area outside ROI was set to zero using logical indexing, and the extracted section is shown. In the original photos, for instance, extraneous symbols (such as the tick mark in the normal image) or text (such as B in the COVID19 image) were eliminated during the ROI stage[10].

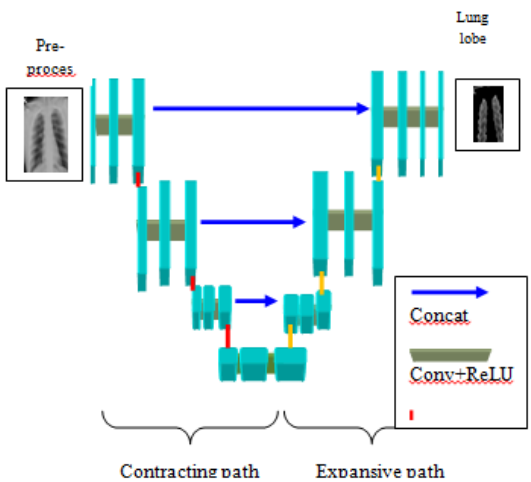
Lung Lobe Segmentation

The input for segmenting the lung lobes is, and U-Net is used to process the segmentation. The regions of the lung lobes are segmented from the pre-processed image in this stage. The U-net approach has the advantage of great segmentation efficiency and processing speed. The next section describes the U-structural net's design.[4].

U-net Structure:

U-net model refers to the U-shape arrangement of the U-net architecture. The U-net scheme includes both a contracting path and an expanded path. In this case, the contracting path is on the left lateral and the expanding path is on the right lateral. The contracting path of the U-net architecture consists of two convolutional layers, each followed by a Rectified Linear Unit (ReLU), and a pooling layer with two downsampling strides. For each step of the

downsampling procedure, the number of feature channels must be doubled. The feature channel is cut in half as a result of upsampling based on a feature map with convolutional layers followed by ReLU layers at each step of an enlarged path. This technique resulted in border pixel loss, necessitating the cropping procedure for each convolution. Finally, the full feature vector is mapped to the necessary class count using the convolution layer. The U-net model's architecture is depicted in Figure 2 [4].



Feature Extraction In Machine Learning Vs Deep Learning

Deep learning and conventional methods are very different from one another because deep learning can automatically learn features from large amounts of data instead of adopting the handcrafted features, which heavily rely on prior knowledge of designers and make it very challenging to utilize big data. Millions of parameters in huge data can be used to automatically learn feature representation using deep learning.

In order to generate the input features for the network, many common feature extraction techniques are investigated. A selection of feature extraction strategies with suitable performance are chosen for the following stage[5] after reviewing the results. Deep learning overcomes the drawbacks of deep learning models in process of shallow feature learning and has improved recognition efficiency and generalization. It also offers the advantages of strong visualization and automatic picture feature extraction[6].

Feature extraction methods are used to obtain Features that will aid in organising and identifying photos. In this essay, we'll discuss several features, their extraction techniques, and explain when one method over another for features extraction is preferable[7]. The goal of feature extraction is to use less resources to describe big sets of data[15]. Local features in a picture include patterns or distinctive structures like points, edges, or small image patches. Feature extraction reduces number of dimensions in a data

collection with increased dimensionality. As a result, it is helpful for data visualisation since reducing a complex data set to two or three dimensions allows for good visualization[15]. It has significant reference value for the future high-efficiency experimental study on the extraction of the best image features[8]. It is important to investigate the connection between the quantity of features and the outcome. It defies logic to assume that the more features there are, the better the performance will be. It uses feature representation techniques. The final performance of block-based and region-based features, in particular, is influenced by the size of the segmentation or partition[16]. Instead of utilising all feature extraction techniques, we suggest employing the feature selection method in future work [17].

Feature extraction is a critical step in image retrieval, processing, data mining, and computer vision (FE). The FE process is used to filter out relevant information from raw data. In this study, it was demonstrated that the most distinctive features that can be extracted when applying GLDS features to images include contrast, homogeneity, entropy, mean, and energy. Additionally, it was demonstrated that FE techniques are not generally application-specific and may be applied for a range of applications[18].

Feature Extraction Types:

a) Pixel Features : For grayscale images, the size of the image and the number of pixels are the same. By altering the image's shape and returning the image in array form, we can determine the pixel features. Ex:pixel_feat1 = np.reshape(image2, (1080 * 1920)

b)**Edges :** Edges are locations where two image sections are separated by a line (or an edge). In actuality, edges are typically thought of as collections of points in image with significant gradient magnitude. As the photos are kept in array form, we may visualise different values and observe where the change in pixel value is higher, but doing it manually takes time[19]. The corners of a picture that have a significant pixel change are called edges. Scikit-Image offers the following functions for extracting image edge features: Using Prewitt Kernel It is an edge detection kernel that handles the horizontal and vertical axes independently.

c)**Corners / interest points:** When referring to point-like components of a picture with a local two-dimensional structure, the corners , interest points are occasionally interchanged. The term "Corner" comes from early algorithms that

first performed edge detection before analysing the edges to find abrupt changes in direction (corners). These techniques were then developed in order to do away with the requirement for explicit edge identification, such as by looking for noticeable curvature in the image gradient[20].

d) **Blobs / regions of interest points:** Blobs, as opposed to corners, which are more point-like, provide complementary representation of image structures in terms of areas. But many blob detectors may be thought of as interest point operators because blob descriptors frequently include a preferred point.

e) **Ridges:** The idea of ridges is a useful tool for extended items. The generalization of medial axis can be seen in ridge descriptor generated from grey-level image. However, ridge features from a wide classes of grey-level images are algorithmically more difficult to extract than edge-, corner-, or blob features. Low-level feature extraction can be done directly from source images, however high-level feature extraction depends on it[20].

f. **Colour Features** A portion of a publication (such as a newspaper or magazine) known as a colour piece (or colour feature) focuses mostly on impressions or descriptions of the subject matter. It focuses mostly on the descriptive elements.

g. **Texture Features** An image's perceived texture can be measured using a set of metrics calculated during image processing. Information regarding the spatial arrangement of colour or intensity in an image, or in a particular area of an image, is provided by image texture.

h. **Shape Features** Shape is a key visual element and a fundamental aspect for descriptions of image content. Since it might be challenging to compare shapes, it is impossible to specify exactly what a shape's content is[20].

CNN feature extraction This section shows how the CNN feature was extracted, as shown in figure 3. The CNN convolutional layer provides the data for the CNN feature. Convolutional (conv) layers, pooling (pool) layers, and fully connected (FC) layers are the three layers that make up CNN's structure. The segmented or interested lobe region is where the CNN characteristics for this study were obtained.

These networks can learn a wide variety of intricate traits thanks to their deep design, which is something a simple neural network cannot do. The fundamental idea

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behind CNN is to gather local features from input—typically an image—at upper levels and then combine them at lower layers to create more complex features [19].

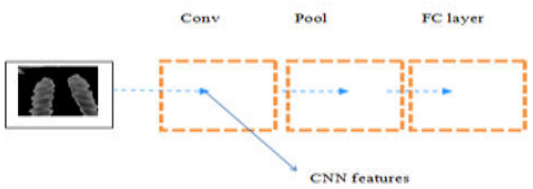


Figure 2 Extraction of CNN features

A typical Convolutional Neural Network architecture consists of the following layers:

a) ***Convolutional Layer*** The fundamental component of a convolutional neural network is the convolution layer, which substitutes the convolution operation (shown by an asterisk *) for conventional matrix multiplication. A series of lernable filters, usually referred to as kernels, make up its parameters. The primary function of the convolutional layer is to identify local features present in the input image that are shared by all local regions in the dataset and transfer their appearance to a feature map. Convolution operation is described as follows:

$(i,j) = (I * K)(i,j) = \sum\sum I(i + m,j + n)K(m,n)\, nm \qquad Eq\ (1)$

I stands for the input matrix (picture), K for the size m x n 2D filter, and F for the 2D feature map output. The feature map F is created in this case by convolving the input I with the filter K. I*K stands for this convolution operation. Each convolutional layer's output is fed into an activation function, which adds non-linearity. There are many activation functions, but the Rectified Linear Unit is the one that is accepted for deep learning (ReLU). ReLU merely thresholds the input at zero to compute the activation. In other words, ReLU produces raw output if the input is greater than 0 and 0 otherwise. It is specified mathematically as: $(x) = \max(0,x) \qquad Eq(2)$

b) ***Subsampling (Pooling) Layer*** To reduce the spatial extent of the input and hence the number of parameters in the network, a pooling or down sampling layer is optionally included after the convolution layer in CNN. The most popular pooling method is called Max Pooling, which merely outputs the highest value possible from the input region. L2-norm pooling and average pooling are further choices for pooling.

c) ***Fully Connected Layer*** Each neuron in the fully connected layer is linked to every neuron in the following layer, and every value helps anticipate how closely a value resembles a certain class. The class scores are then output from an activation function after the output of the final fully linked

layer. $Zk = exk \sum exn \; n \; i=1$ Eq (3)

here the input vector is x, and the output vector is Z. All outputs added together (Z) equal 1. The class to which the input chest X-ray image belongs will be predicted by the proposed model.

A complete CNN architecture is made up of all the levels mentioned above. In addition to the primary layers listed above, CNN may also use optional layers to mitigate overfitting and enhance training time, such as the batch normalisation layer and dropout layer[21].

Traditional Algorithms for image classification:

i)*Gaussian NaiveBayes :* A probabilistic machine learning model called Naive Bayes classifier is utilized for binary and multi-class classification issues..

ii)*Support vector machine*: For classification and regression problems, the SVM supervised machine learning method is used. It does categorization by identifying the hyper-plane that successfully separates the classes. By increasing margin, it discovers hyper-plane[22].

Iii)*Decision tree classifier*: In a decision tree, which resembles flowchart, an internal node represents a function/attribute , branch represents a decision, and each leaf node reflects the outcome. A decision tree's root node located at the top. It gains the ability to segment data based on an attribute's value. A technique for recursively partitioning the tree is called recursive partitioning[22].

iv)*Logistic Regression* A popular mathematical technique for forecasting binary outcomes (y = 0 or 1) is logistic regression.

While logistic regression is appropriate for categorical outcomes (binomial/multinomial values of y), linear regression is useful for projecting outcomes with continuous values.

v)*Randomforest* A supervised learning algorithm is random forest. A collection of decision trees, which are often trained using the "bagging" technique, are combined to form a "forest." The basic idea behind the bagging method is that combining several learning models enhances the result.

Vi) *Ensemble learning* In order to build strong model, base models are carefully combined to form ensemble model. To tackle a classification/regression problem that neither of individual models can easily handle, the ensemble model uses a variety of learning algorithms. Using ensemble learning, one can outperform a

certain model in terms of performance (Wolpert, 1992)[22].

vii) **Proposed method :**Henry Gas Water Wave Optimization-based Deep Generative Adversarial Network (HGWWO-Deep GAN) is identified for covid-19 detection process. HGWWO algorithm can be designed by the combination of both Henry Gas Solubility Optimization (HGSO), Water Wave Optimization (WWO) algorithm[4].

Methodology :

In this section, we will discuss the work methodology for the proposed technique, model architecture, implementation and training.

Step 1: **Acquisition of input data**

consider the database N with q number of Chest X-Ray images, which is described as,

$$N = \{G_1, G_2, ..., G_k, ..., G_q\}$$

(1)

where, G_k represents the kth image from the database, q describes the total count of image in database. Here, the input image G_k is considered for further processing of detection.

Step 2:

The median filtering is applied to the input image G_k in order to eradicate the noise and distortions exist in the image. Median filtering is a non-linear approach, which is used to remove the impulse noise with salt and pepper noise present in Chest X-Ray image. The expression for median filtering process is given by as follows.

$$H(r,s) = median_{(P_1) \in D_{r,s}} \{f(P_1)\}$$

(2)

where, r and s indicates the image samples. The median filter outcome is designated as H_f.

Step 3: Following median filtering, ROI extraction is done. The benefit of adopting the ROI extraction procedure is that it improves the efficiency of the COVID-19 detection process.

In ROI extraction process, the ROI region is extracted from the filtered image R_f, and it is forwarded to the input of lung lobe segmentation process.

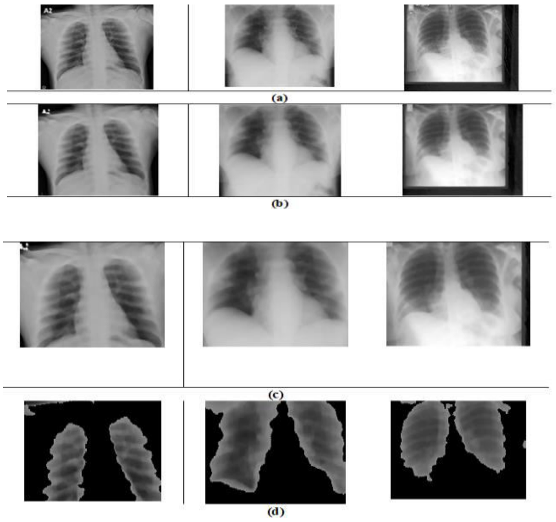
Step4: The lung lobe segmented region is obtained from U-net model represented as M_s.

Step5: The input of CNN feature extraction is a segmented lobe region M_s. And the extracted CNN features are represented as W_s.

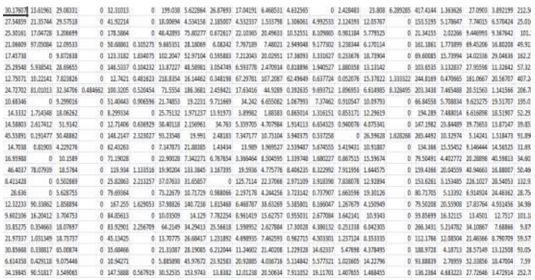
Step6: Covid -19 detection process using HGWWO based Deep GAN technique implementation is covered in another paper[4]

Results Discussion:

- The partial implementation outcomes of COVID-19 detection is presented in figure 3. Figure 3a) presents the original Chest X-Ray image, pre-processed median filter image shown in figure 3 b)



pre-processed ROI image is shown in figure 3c) , and lobe segmented image is specified in figure 3d)Features extracted using CNN



Cross validation The statistical technique known as cross validation is used in machine learning algorithms to evaluate the approaches. The foundation of this approach is splitting the data into two portions for model training and validation. The most popular type of cross validation is k-fold cross validation.The dataset is divided into k equally-sized pieces (folds) in this procedure in order to train and evaluate the model. The model is validated using a different fold for each iteration of the training and validation procedure, which is carried out across k iterations. The performance of all the folds is then averaged to determine the overall performance[23].

Conclusion:

The benefits of deep learning include strong visualisation, automatic image feature extraction, and greater generalisation and recognition rates. The primary needs for any deep network are vast image datasets and powerful computing power. In many applications and academic sectors, feature extraction is a well-liked and practical method. This article conducted a survey of the methods, varieties, and uses of FE. The CNN feature was chosen for recognition mostly because

it is more potent and effective because it contains more pertinent information about segmented region, which increases the accuracy of the recognition process. As part of implementation, In this research to reduce noise from the images, pre-processing techniques like Region of Interest (RoI) and median filtering are used. Utilizing U-net architecture, implementation of lung lobe segmentation, and lung region extraction is carried out using Convolutional Neural Network (CNN) characteristics. In addition, we can use HGWWO algorithm to train Deep GAN, which can be used for COVID-19 identification.

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