Chapter-1

Covid-19 Detection in Lungs using CNN

1.1 Introduction

The detection of COVID-19 in the lungs involves various diagnostic methods aimed at identifying the presence of the SARS-CoV-2 virus, which causes the disease. Understanding and identifying the virus within the lung tissue is crucial for prompt treatment and containment of the infection.

The outbreak of the novel coronavirus, SARS-CoV-2, which emerged in late 2019, has resulted in the global COVID-19 pandemic. The virus primarily affects the respiratory system, causing symptoms ranging from mild respiratory issues to severe pneumonia and acute respiratory distress syndrome (ARDS). Detecting the presence of the virus in the lungs is a critical step in diagnosing COVID-19 and implementing appropriate medical interventions.

The COVID-19 pandemic's global expansion has resulted in severe fatalities. The truth that the COVID-19 was found quicklyis one of the most significant concerns that healthcare sector sectors are dealing with. As a result, it's critical to confirm the suspicious case's diagnostic, not only to make the following stepeasier for the victims, but also to minimize the number ofinfected individuals. Because of its reasonable cost, broadrange of use, and rapid speed, X-Ray testing is the most widely utilized Chest X-Ray diagnostic approach. It's important forCOVID-19 illness diagnosis and patient assessment. One may utilize Chest X-Ray to determine the condition of the patient's lungs since COVID-19 affects human respiration epithelial cells.This has become a major goal to figure out how to identify these characteristics on a chest X-ray.

In image identification, the deep convolutional neural network has made exceptional progress, particularly in the field of auxiliary diagnosing technologies. Neural networks have demonstrated effectiveness at detecting pneumonia from X-rays,outperforming radiologists. Ransom forest classification can be used to classify the x-ray images and the decision can be taken by comparing them with the database images. Figure 1 shows the x-ray picture of lungs infection.

The corona virus illness epidemic that began in China in December 2019 quickly expanded around the world by January 2020. On January 30, 2020, the WHO designated it as COVID- 19 and proclaimed it a pandemic. The number of confirmed cases is expected to reach 700 million by December 8, 2020, with a global mortality rate of 3-4 percent. Because it is a highly contagious viral disease that spreads quickly, authorities in virtually all of the afflicted nations are prioritizing the isolation of sick people as soon as feasible. COVID-19 patients experience flu-like high fever, coughing, dyspnea, respiratory difficulties, and viral pneumonia. However, these symptoms are insignificant on their own. Many people are asymptomatic, but whose chest CT scan and pathogenic test both come back positive for COVID-19. As a result, positive pathogenic tests and positive CT images / X-Rays of the chest are often used to identify the condition, in addition to ill complaints. The main objective of this paper is classification of Covid-19 Disease using chest X-Ray images in deep learning techniques.

This paper focuses on model combination and transfer learning. COVID-Net, an open standard technique to identify COVID-19, is the foundation of the methodology. To begin, load data and address the issue of imbalanced data. Then integrate transfer learning with a deep network that has been improved. Lastly, chose the models ResNet-101 and ResNet-152 with excellent fusion effect based on accuracy and loss value, and proactively increase their weight ratio during learning process. Establish a well-closed loop and modify repeatedly.

Deep learning has performed a critical part in the reaction to the COVID-19 pandemic, allowing for correct judging and reaction to the epidemic. On Computed Tomography (CT) chest x-ray pictures, the method will build analytic and medical skills of deep learning and offer an image classifier relying on the Convolutional Neural Network (CNN) . The goal of this method is to determine if the outcome is conventional or COVID-19.

COVID-19 is a disease, caused by a virus (SARS-CoV-2). Infections in the lungs can range from a simple cold to a life-threatening condition. Symptoms of the respiratory system often accompany infections caused by coronaviruses. Individuals may have minor, self-limiting illnesses with adverse effects like influenza on rare occasions. Fever, cough, and difficulty breathing are among the symptoms of respiratory issues, weariness, and a sore throat. The use of X-rays and computed tomography scans is one of the fundamental approaches to diagnosing COVID-19. Chest imaging is a quick and efficient method suggested by medical health regulations, and it has been highlighted in several papers as the first instrument in epidemic screening. Different computer vision approaches are used, such as segmentation and classification. When a quick and straightforward method running on limited computing devices is needed, an automated technique that can provide fragmentation and measurement of the infection region of patients every three to five days and monitor the evolution of infected patients through CT scan imaging and clinical detection is required. COVID-19 is a difficult disease to diagnose, even for expert doctors.

Many studies have been undertaken on the use of deep learning in the interpretation of radiological images. They have been undertaken to solve the constraints of COVID-19 medical techniques based on radiological images. The CNN architecture is the most effective approach for detecting it among the most significant deep learning algorithms. Data processing of deep learning algorithms, notably CNN, has received much interest.

In early 2020, the COVID-19 outbreak became a worldwide epidemic. The World Health Organization declared a significant international public health emergency, and the condition was considered a health emergency. Automatic detection of lung infections through CT scans provides an excellent opportunity to extend traditional healthcare methods to address COVID-19. But CT has many problems. CNN is used to detect lung tumours, pneumonia, tuberculosis, emphysema, or other pleural diseases. The disadvantages of the CT system are as follows: because the contrast of the soft tissues is lower than that of the MRI, it is an X-ray Radiation exposure.

Using deep learning algorithms, the suspected patient's X-ray and CT scan can be distinguished between a healthy person and a COVID-19 patient. Deep learning models are employed in creating diagnosis systems for COVID-19. DenseNet121, VGG16, Exception, Efficient Net, and NAS Net are the architectures employed, and multiclass classification is used. Positive individuals with COVID-19, regular patients, and other patients are also considered. Chest X-ray images indicate pneumonia, flu, and other chest-related disorders that belong in another category. VGG16 achieves 79.01% accuracy, Efficient Net achieves 93.48 accuracy, Exception achieves 88.03 accuracy, NAS Net achieves 85.03 accuracy, and DenseNet121 achieves 89.96% accuracy.

- Python programming version 3.0 or higher is required for this system's development. Jupyter Notebook that runs on the Anaconda Framework should be used as the adaptive management component. The development's functional needs are among the most essential components; the system's major functional need is listed here.
- The covid-19 from a chest X-ray must be classified by thismethod.
- There must be 2 notebooks: one for preparing the data andtraining it, and another for testing the data, which implies predicting the sample input classification.
- When the data has been retrieved, 80 percent of the information must be allocated to the training phase, while the other 20% must be allocated to the assessment process.
- After the training set has been created, it must be entered into CNN, ResNet, and Alex Net process.
- In CNN, ResNet, and Alex Net, the Convolutional Layers, Rectified Linear Unit, and Max Polling layers must be executed one after the other.
- The steps above must be continued till the training dataprecision is achieved.
- When the correctness of the testing set has been achieved,the fully connected layer procedure must begin.
- After the learning procedure is done, the testing procedureand the confusion matrix must be produced.
- This method must have an efficiency of at least 85%.

1.2 System Architecture:

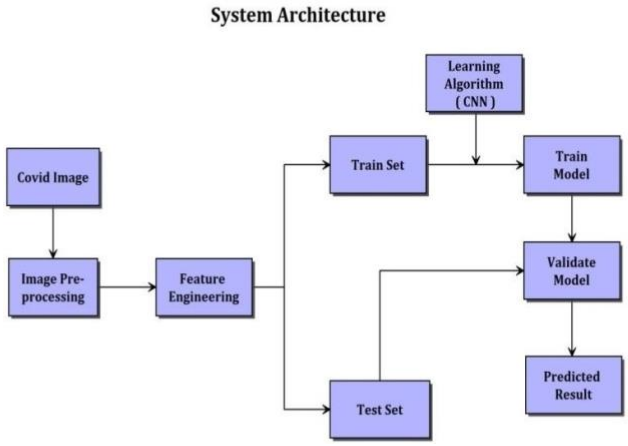

Fig. 2.1

The model COVID-Net presented by Darwin AI, Canada, is among the most important developments. A deep convolutional neural network that can recognize COVID-19 patients from X-ray pictures of the chest. At the very same moment, the COVIDx datasets of chest X-ray scans, that were used for COVID-Net training and assessment, was made openaccess.

The paper has been organized as follows, section 2 describes the literature survey, section 3 depicts system design, section 4 explains system requirements specifications, section 5 shows the results and analysis and finally, section 6 concludes the paper.

1.3 Literature Survey:

In author describes that, in December 2019, the first infectious new Coronavirus case (COVID-19) was discovered inHubei, China. The COVID-19 epidemic has expanded to 214 nations and regions throughout the world, affecting nearly everyfacet of human existence. At the moment of writing, the number of infected cases and fatalities continues to rise dramatically, with little evidence of a very well scenario. For example, on July13, 2020, 571527 deaths were recorded worldwide, out of a totalof roughly 13.1 million confirmed cases. This study seeks to emphasize the relevance of artificial intelligence (AI) and big data in light of current advancements and uses in many fields. We begin by providing an introduction of AI and big data, then explore technologies targeted at combating COVID-19, then emphasize problems and issues connected with province technologies, and lastly make a recommendation for successful COVID-19 scenario reporting. This article intends to provide academics and the general public with important discoveries on how AI and big data might help with the COVID-19 issue, and also to encourage more research into how to control the COVID-19 outbreak.

The COVID-19 has put the entire globe in an extremely terrible position, giving life to a terrifying standstill and taking millions of lives all across the globe. COVID-19 is a significant danger to the public healthcare system since it has expanded to 212 nations and territories, with a rising infected patients and casualty figures of 5,212,172 and 334,915 (as of May 22 2020). This article proposes an Artificial Intelligence-based solution to fight the infection (AI). To achieve this aim, Deep Learning (DL) approaches such as Generative Adversarial Networks (GANs), Extreme Learning Machine (ELM), and Long/Short Term Memory have been demonstrated (LSTM). It outlines a comprehensive bioinformatics strategy wherein various elements of data from a variety of diverse data resources are combined to provide user- friendly interfaces for experts. The major benefit of such AI-based solutions is that they can speed up the evaluation and management of COVID-19. The most current linked articles and hospital records were studied with the goal of selecting network inputs and goals that might aid in the development of a viable Artificial Neural Network-based solution for COVID-19 problems.

The humanity was attacked by a global epidemic of COVID-19, a member of the Coronavirus family, in 2020. People began to have conflicting views about the scenario due to the quick growth in illness and fatality rate. As a result, the only purpose of this research is to examine the feelings displayed by persons who use social media sites like Twitter. Keeping track of and examining the troubling tweets can help to evoke genuine feelings during this difficult period. The purpose of this research is to offer a domain-specific method to understanding how individuals throughout the world feel about this issue. Corona-specific messages are obtained from the Twitter network in order to do this. Just after tweets are gathered, they are tagged, and a model is created that is capable of recognizing the true emotion behind such a tweet about COVID-19.

In order to build the considerable evaluations are conducted in a bi-class and multi-class scenario over an n-gram feature set, as well as a cross-dataset examination of several machine learning approaches. The studies show that the suggested model does a good job of detecting people's perceptions of COVID-19, with a high precision of around 93 percent.

In Machine learning (ML)-based prediction models have demonstrated their use in predicting prior conditions and improving decision-making about future activities. Machine learning techniques have long been used in several important applications that needed the identification and prioritization of negative risk factors. A number of prediction techniques are extensively used to cope with prediction problems. This research illustrates the capacity of machine learning models to predict the number of patients who would be impacted by COVID-19, which is now regarded as a possible threat to humanity. In this work, 4 main prediction models were employed to anticipate the dangerous variables of COVID-19: linear regression (LR), least absolute shrinkage and selection operator (LASSO), support vector machine (SVM), and exponential smoothing (ES). During the next 10 days, each prototype provides three types of predictions: the rate of new illnesses, the proportion of mortality, and the percentage of recoveries. The study's findings show that using these approaches in the present COVID-19 outbreak scenario is a possible mechanism.

The mentions that rapid and reliable COVID-19 identification is enabled by precise SARS-CoV-2 test, decreasing the pressure on healthcare organizations. Prediction techniques which combine several parameters have been developed to estimate the risk of transmission. These would be designed to assist medical workers across the world in tracking casualties, particularly in places with little healthcare facilities. They created a machine-learning system based on the data of 51,831 persons who had undergone testing. The statistics in the testing set came from the next week. With just 8 binary variables, the model can predict COVID-19 testing results with excellent accuracy: sex, age 60 years, confirmed interaction with an infected person, and the emergence of five early clinical signs. Altogether, they built a model that predicts COVID-19 instances using simple characteristics obtained by questioning basic information, based on countrywide data publicly provided by the Israeli Ministry of Health. Whenever testing resources are insufficient, the methodology may be used to prioritize assessment for COVID-19, among several other things.

1.4 System Design:

System Architecture

The link among various components would be depicted using a proposed system model. Typically, they are made for systems that involve both hardware and software, that are depicted in the Fig. 2 to demonstrate how they interconnect.

- **Transfer learning:**

A model learned on one activity is reused to another similar activity via transfer learning, which generally involves some modification to the new assignment. For instance, on a smaller dataset, one may use an ImageNet-trained picture classification model to start task-specific learning for COVID-19 identification. Transfer learning is most beneficial for situations when there aren't enough training samples to build a model from the ground up, such as medical picture categorization for uncommon or developing illnesses. This is especially true for deep neural network models, which have a large number of parameters to train. Deep learning is a sub-field of machine learning that is inspired by the brain's structure. In the medical field image analysis, like in many other sectors, deep learning approaches have continued to demonstrate amazing results in recent times. It is hoped that by employing deep learning algorithms to health records, relevant findings may be extracted. Deep learning models have already been effectively used to health data categorization, segmentation, and disease identification. Deep learning models are used to analyze image and signal information gathered using medical imaging techniques such as magnetic resonance imaging (MRI), computed tomography (CT), and X-ray. As a consequence of these studies, illnesses such as diabetes, brain tumors, skin cancer, and breast cancer can be detected and diagnosed more easily.

To better accommodate the variables of each layer, the deeper the NN, more and more information testing is essential. Otherwise, over fitting is quite easy, leading in weak prediction accuracy. As a result of this issue, transfer learning is a viable option. It tends to make full advantage of the generalization capabilities of big data sets to train models, then moves on to smaller chest X-Ray data sets to begin training. They believe that by doing so, the DNN's interpretations learnt in the first set will aid the model's adaptation in the subsequent. The ImageNet dataset was used to train ResNet101 and ResNet152.

ResNet101 and ResNet152 transfer learning have comparable training processes. To demonstrate, let's use ResNet101 as an example. The pre-trained ResNet101 model is utilized, and the fully connected layer is deleted, as per transfer learning. The pooling layer is again attached to the feature map by a new completely connected layer (three labels: normal, COVID-19, and viral pneumonia). Lastly, a ResNet101-based transfer learning model is trained. Despite the small quantity of dataset, the model doesn't really over fit.

- **Model learning:**

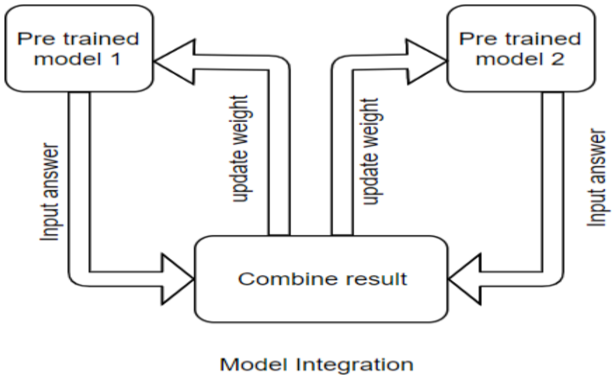

Fig. 2.2

Under joint learning, the two concepts having the best performance in the transfer learning phase are combined. It begins training by locking all of the network parameters of such network entities during that point. In additionally, the output layers of such two models are given different weights. The testing dataset verifies the percentage of output from the two, and the value of the higher success rate is stronger, and vice versa. The model combo is made up of pre-trained model 1 and pre-trained model 2. During training phase, the importance of enhancing the accuracy is increased. The resultant model is quite stale, particularly throughout the training phase.

CNNs (convolutional neural networks) are a form of deep- NN that can help with object recognition. In attempt for CNN to work, the images supplied as input must be recognized by systems and converted it into representation that can be processed. As an outcome, images are first converted to matrix. The system determines which image matches to which label based on picture discrepancies and hence matrices. It recognizes the influence of these differences on the labeling even during the training period and utilizes them to produce forecasts of future pictures. CNN contains three layers to carry out such operations: a convolutional layer, a pooling layer, and a fully connected layer. The both convolutional and pooling layers are involved inthe feature extraction phase. The classification process, from theother side, takes place in the fully linked layer.

- **Flow chart:**

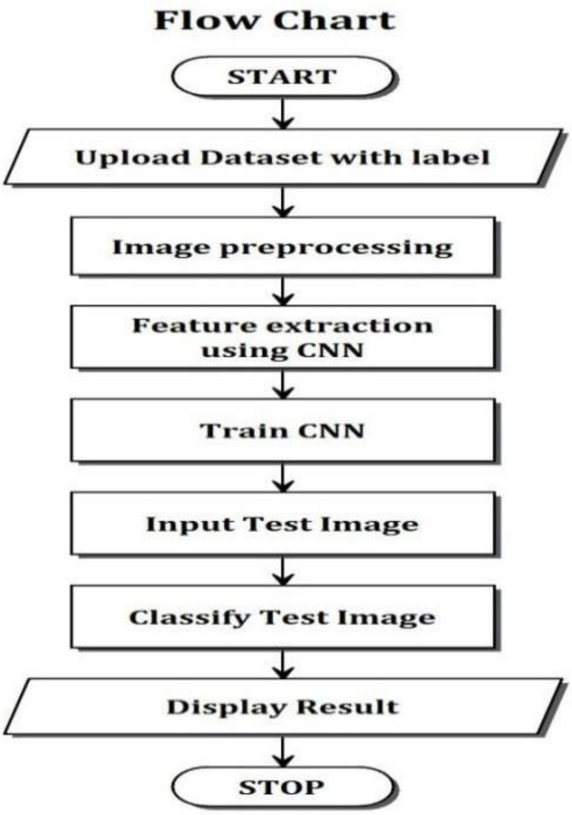

Fig. 2.3

A flowchart is among the seven fundamental quality tools used during project management, and it depicts the activities required to achieve the objectives of a job in the most feasible order. This sort of tool, often known as process maps, depicts a set of stages with splitting options that show one or more inputsand changes them to results. The flowchart of the proposed works.

Flowcharts have the benefit of displaying all of the actions associated with the project, particularly critical points, parallel pathways, branch loops, and the total computation sequence, byintegrating specific details inside the horizontal supply chain. Furthermore, this technique is frequently utilized in evaluating and comprehending the quality costs for a certain procedure. This is accomplished by utilizing the workflow's branching logic and calculating the projected monetary rewards.

- **User case Diagrams:**

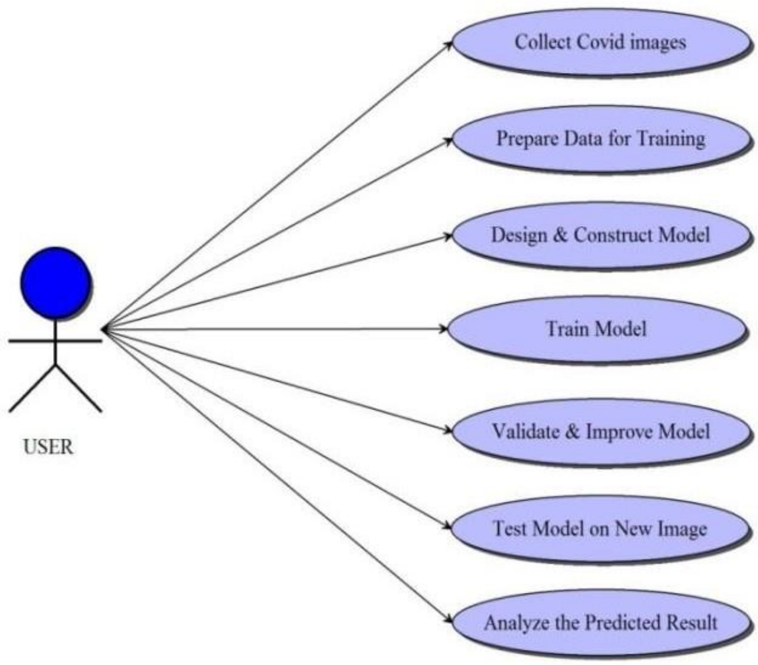

Fig. 2.4

A use case is a collection of situations that describe how a source and a destination connect. The link between actors and use cases is depicted in a use case diagram. Use cases and actors are the two primary components of a use case diagram. The usecase diagram is shown below.

- **Data Flow Diagram:**

- A data flow diagram (DFD) depicts the "flow" of modeling its process aspects graphically. A data flow diagram may be used to visualize data processing as well (structured design). A designer's standard procedure is to create a context level DFD first, which depicts the system's relationship with external elements. DFDs depict the flow of information entering the system from external sources, and how the information travels from one operation to the next and its logical preservation. Merely four symbols have been used.
- External entities, that are sources and destinations of knowledge entering and exiting the network, are representedby squares.
- Rounded rectangles depicting activities that receive data as input, analyze it, and output it are known as 'Activities,' 'Actions,' 'Procedures,' 'Subsystems,' and so on in different approaches.

- Data flows are represented by arrows that might be digital information or physical things. Information cannot transfer from one data store to another without the use of a procedure, and external entities are not permitted to retrieve storage arrays immediately.
- The flattened three-sided rectangle represents data storage that must jointly accept and provide information for any further computation.

Level 0 data flow diagram

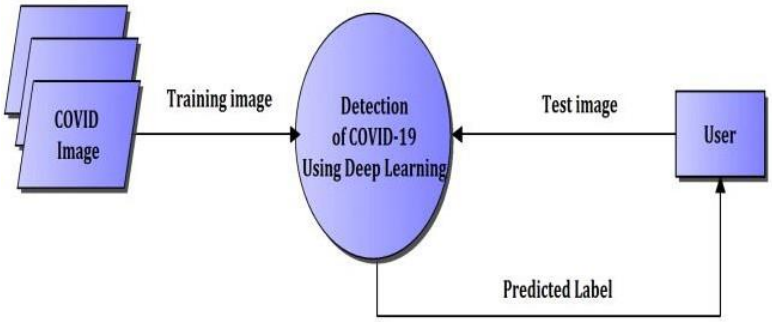

Fig. 2.5

Level 1 data flow diagram

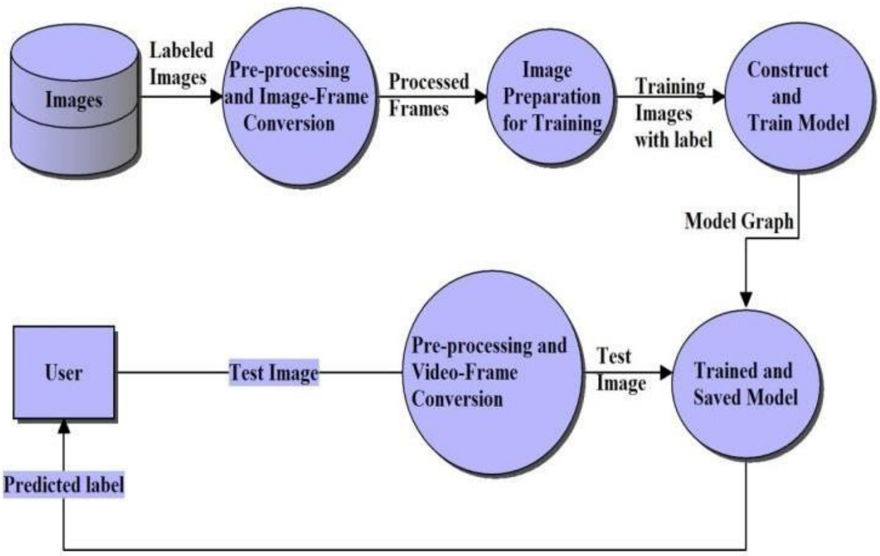

Fig. 2.6

- **Sequence Diagram:**

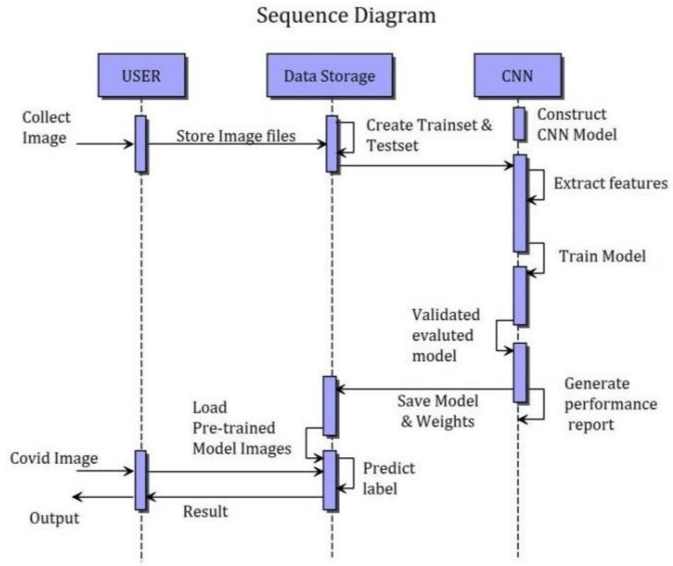

Fig. 2.7

A sequence diagram as shown in figure 8 simply depicts the sequence in which objects link or these activities take place. An event diagram is another name for a sequence diagram. Sequence diagrams demonstrate in what proportion the various components of a system interact.

- **BLOCK DIAGRAM**

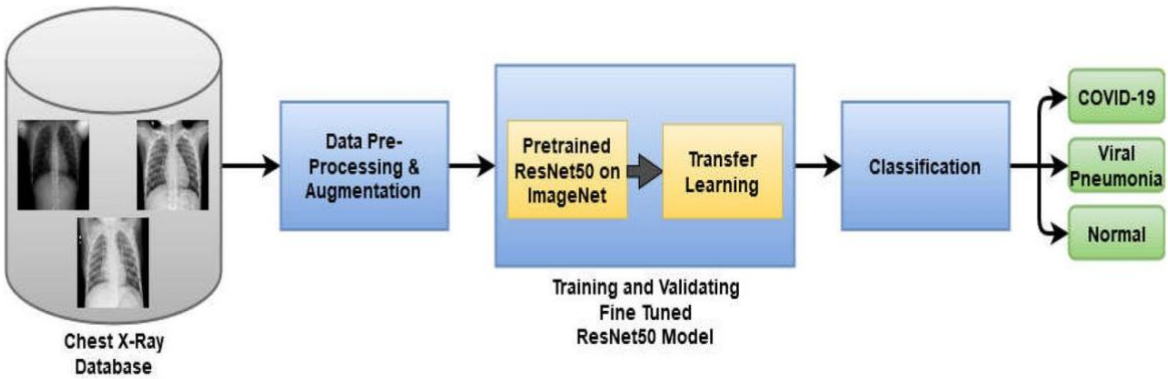

Fig. 2.8

- **Image Acquisition:**

 - CT scan or X-ray imaging

- **Preprocessing:**

 - Image pre-processing techniques (e.g., noise reduction, contrast enhancement)

- **Region of Interest (ROI) Selection:**

 - Segmentation to identify lung regions

 - Extraction of the specific area of interest

- **Feature Extraction:**

 - Extraction of relevant features (e.g., texture, shape, density)

- **Feature Selection:**

 - Selection of discriminative features

- **Classification:**

 - Machine learning or deep learning models:

   - Convolutional Neural Networks (CNNs)

   - Support Vector Machines (SVMs)

   - Random Forests, etc.

 - Training of the model using extracted features

- **COVID-19 Detection:**

 - Decision-making based on classification output

 - Probability estimation or binary classification

- **Post-processing:**

 - Analysis of detected regions

 - Refinement of results (if required)

- **Reporting and Visualization:**

 - Displaying the detected COVID-19 regions

 - Generating a report for further analysis or medical consultation

- **Integration:**

  - Integration with medical systems for reporting and monitoring

  - Feedback loop for continuous improvement

- **Validation and Evaluation:**

  - Validation of the detection model performance

  - Evaluation of accuracy, sensitivity, specificity, etc.

- **Deployment:**

  - Deployment of the system for clinical use

1.5 Result and Analysis:

This section depicts the results of the proposed work. A result seems to be the qualitative or quantitative depiction of the end outcome of actions or occurrences. Performance analysis is a type of action plan that consists of a set of fundamental quantitative relationships between performance dimensions. Lungs X-ray images from two datasets formed the COVID-Xray- 6k dataset that contains 2400 training and 3600 test images. One of the used datasets is the recently published Covid-lung x-ray Dataset, which contains a set of images from publications on COVID-19 topics, collected (gethub.com). This dataset contains a mix of lung X-ray and CT images. The testing has been conducted by considering the test images (X-Ray and CT images) and simulated. The prediction class and results are obtained after going through the confusion matrix.

- **Final Results**

The results of sample x-ray images collected from the patients and their equivalent results. Figure show that the person's x-ray indicates that the person is not infected with Covid-19 and he/she needs normal medication. Figure 10 shows that the person's x-ray indicates that the person is infected with Covid-19 and he/she needs immediate medication.

Imaging of the heart, lungs, blood arteries, airways, and the bones of your chest and spine are produced by standard chest X-rays. Fluid in or around the lungs, as well as air surrounding a lung, can be seen on chest X-rays.

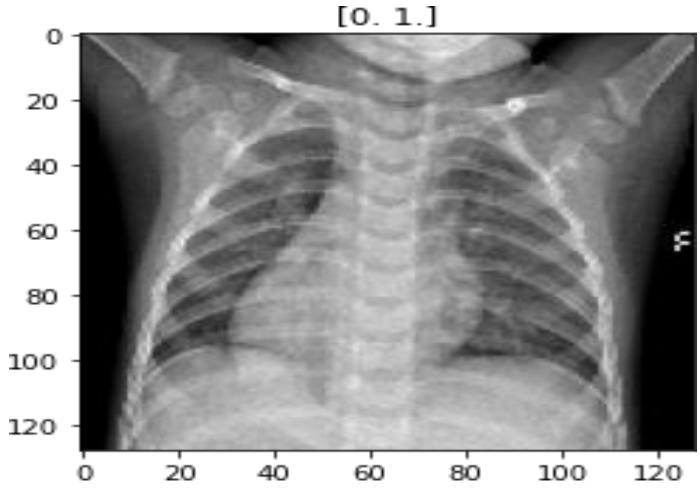

Fig 2.9

A ground glass pattern (ground glass opacity) appears when lung marks are partially hidden by increasing whiteness. This could be subtle, and a radiologist may be needed to confirm it. Ground glass opacity may indeed be accompanied by peripheral,coarse, horizontal white lines, bands, or reticular alterations that can be characterized as linear opacities. Consolidation occurs when the marks on the lungs are entirely erased owing to the whitening (this is usually seen in severe disease). Seventy percent of the radiographic opacities in individuals with polymerase chain reaction (PCR) proven covid-19 infections were detected among those with radiological anomalies. The same has been shown in Figure below:

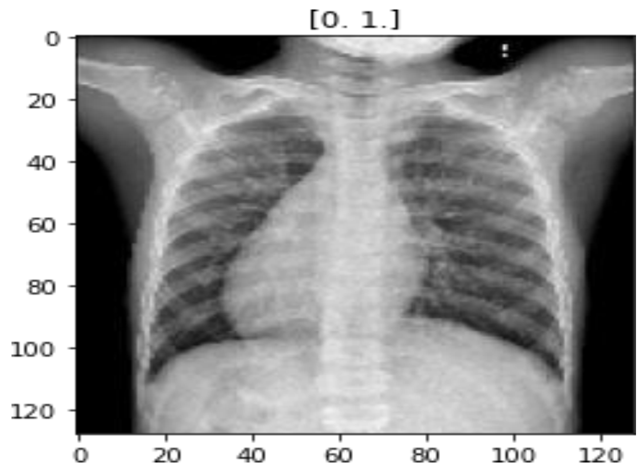

Fig. 2.10

Conclusion

Deep learning has performed a critical part in the reaction to the COVID-19 breakout, allowing for correct judging and reaction to the pandemic. On chest radiographs, we investigated the analytical and diagnostic capacities of deep learning and proposed a classification model based on the COVID-Net to categorize chest X-Ray pictures. Our approach is designed to transfer learning, integrate models, and categorize chest X-ray pictures into two categories: normal and COVID-19. Choose the models ResNet-101 and ResNet-152 with good fusion effect based on accuracy and loss value, and then dynamically modify their weight ratio during the preprocessing step. On the training dataset, the model can accurately reproduce 96.1 percent of the classes of lung X-Ray pictures following training. It serves as a reference tool for medical and health facilities, government agencies, and even worldwide COVID-19 pandemic diagnostics.

References