A Review on Pneumonia Detection Using Image Processing Techniques

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Abstract—Due to their environment and way of life, people today experience various diseases. So, it is critical to identify issues at an early stage. However, it is challenging for a doctor to make an exact diagnosis based only on symptoms. Accurate diagnosis of a problem is the most challenging task to complete. The key to resolving this problem is to foresee the illness using data mining. The amount of data in the medical sciences is expanding quickly every year. Early patient treatment has profited from the proliferation of data in the healthcare and medical industries, boosting the accuracy of medical data analysis. Using illness data, data mining uncovers hidden patterns in a large amount of medical data. The detection and diagnosis of pneumonia are becoming increasingly automated. As we can see, the medical business uses and tests a range of technologies, implying that the detection of pneumonia will probably become less complicated. The approaches for detecting pneumonia using Support Vector Machine(SVM), Image Segmentation, Image Matching-SURF, and Convolutional Neural Networks(CNN) are evaluated in this paper. Pneumonia detection algorithms offer several features that ask for user input before delivering findings.

Keywords— Diseases, detection, sickness, machine learning, pneumonia detection model, Support Vector Machine, CNN, SURF.

1. I. INTRODUCTION

In this survey paper, we will discuss solving a medical problem, i.e., *pneumonia*, a dangerous disease that may occur in one or both lungs, usually caused by viruses, fungi or bacteria. We will detect this lung disease based on the X-rays we have. Chest X-rays dataset will be used to differentiate various X-ray images into *"Pneumonia"* and *"Normal"*. We will be creating a deep-learning model which will tell us whether the person has pneumonia or not having pneumonia. The risk of pneumonia is relatively high for many people, especially in developing countries where billions of people experience energy poverty and depend on polluting kinds of energy. The WHO estimates that diseases related to home air pollution, like pneumonia, cause nearly 4 million premature deaths yearly. Each year, pneumonia affects about 150 million individuals, primarily young children under five. The lack of medical resources and professionals in these areas may worsen the issue. For instance, there is a need for 2.3 million physicians and nurses throughout the 57 countries of Africa. For these groups, prompt and correct diagnosis is crucial. It can provide prompt access to care for individuals already struggling with poverty and help them save much-needed time and money. Reviewing earlier studies on the identification of lung cancer using algorithms including Support Vector Machine(SVM), Image Segmentation, Image Matching-SURF and Convolutional Neural Networks(CNN) is the aim of the study.

2. II. LITERATURE REVIEW

Here, we will summarize our studies about the accuracy and status of existing machine learning algorithms.

Rafael T. Sousa; Oge Marques; Iwens I.G, "Comparative performance analysis of machine learning classifiers in the detection of childhood pneumonia using chest radiographs", 2021-The limitations of human expert-based diagnosis were explored by the author, which served as a compelling argument for the employment of computer tools to increase the efficiency and precision of the detection process. The authors used the image collection utilized in pneumonia to develop a technique for detecting pneumonia using chest radiographs. The coefficient of variation, correlation, and energy are texture-based features chosen, implemented, and tested. With his three classifiers—KNN, SVM, and Naive Bayes—each feature was put to the test. The author used three random sets of 40 photographs each to compare the results, and then he randomly selected 15 images from each set. The author then alternates the subsets in three experiments. Run one as the test and two as the training set. Only the differential variance function and the KNN's k parameter are used for all three tests. The SVM employed standard Gaussian kernel parameters. SVM surpasses KNN and Naive Bayes in this manner. SVM and KNN produced decent results (77% and 70%, respectively), although SVM marginally outperforms KNN in average accuracy. With the best accuracy of 68%, the Naive Bayes classifier placed third.[2]

Joao Victor S.das Chagas; Roberto F. Ivo; Pedro P. Reboucas Filho, "A new approach for the detection of pneumonia in children using CXR images based on a real-time IoT system", 2021- A real-time Internet of Things (IoT) system for identifying pneumonia in chest radiography was suggested by the author in this piece. She had 6000 chest radiographs taken as a child for the dataset, which three medical professionals assessed. This work built resource extractors using 12 alternative convolutional neural network architectures trained on ImageNet. Then, CNNs were merged with integrated learning techniques such as multi-layer perceptrons (MLP), support vector machines, naive Bayes, random forests, and k-nearest neighbours (kNN) (SVM). The findings indicated that the best model for identifying pneumonia on these chest radiographs was her VGG19 architecture with his SVM classifier employing RBF core. For accuracy, F1, and precision scores, this combination received scores of 96.47%, 96.46%, and 96.46%, respectively. The suggested approach produced better outcomes for the used measures compared to other literature publications. These findings show that the real-time IoT strategy to detect juvenile pneumonia is practical, making it a possible tool to support the medical diagnosis. This method enables experts to give the appropriate treatment while obtaining results more quickly and accurately.[5]

Khaled Almezhghwi; Sertan Serte; Fadi Al-Turjman, "Convolutional neural networks for the classification of chest X-rays in the IoT era", 2020- Using this technology, numerous lung disorders can be diagnosed using chest X-ray medical imaging techniques. This method is the most precise one for identifying most chest disorders and is commonly employed in hospitals. Radiologists use these images to spot lung conditions. This procedure, nevertheless, can take some time. On the other hand, automated artificial intelligence systems can support radiologists in more swiftly and reliably diagnosing lung illness. We offer two brand-new deep-learning techniques for quickly and automatically classifying chest X-ray pictures. First, based on the AlexNet model, we suggest using support vector machines. Next, we create a support vector machine using the VGGNet16 approach as a foundation. According to research that combines deep networks with reliable classifiers, the proposed solution beats his AlexNet and VGG16 deep learning algorithms for the chest X-ray classification task. The suggested method offers greater accuracy than conventional methods.[4]

Ayush Pant, Akshat Jain, Kiran C Nayak, Daksh Gandhi, B. G. Prasad; "Pneumonia Detection: An Efficient Approach Using Deep Learning", International Conference on Computing, Communication and Networking Technologies, 2020 - The extensive computer simulations and the persistent learning approach for CT image segmentation using image enhancement are discussed in the paper. This essay offers treatment for acute human illnesses like lung infection or disease. Since December 2019, pneumonia brought on by the novel coronavirus disease (COVID-19) has become a worldwide threat due to the infection's quick spread. At the clinical level, COVID-19 is frequently assessed on chest X-rays or computed tomography scan (CTS) sections. This study aims to create a processing method for images that will allow researchers to analyze a CT scan patient's COVID-19 infection. The Fuzzy DPSO and Hybrid Swarm Intelligence preprocessing algorithms were used to prepare the images for this study. Extensive computer simulations show that image enhancement-based persistent learning strategies for CT image segmentation are more effective and flexible than medical image segmentation (MIS) techniques. The findings demonstrate that the suggested method is more dependable, accurate, and straightforward than the traditional method.[9]

Amit Kumar Jaiswal, Prayag Tiwari, Sachin Kumar, Deepak Gupta, Ashish Khanna, Joel Rodrigues; "Identifying pneumonia in chest X-rays: A deep learning approach", 2019 - The author discusses how regression neural networks with vector quantization have been applied to study chest disease. Many annotated datasets were used to examine how well deep-learning approaches will affect the execution of various medical imaging tasks. Pneumonia causes more than 15% of all deaths globally, including those of kids under five. This article offers a method for locating and identifying pneumonia on chest radiographs based on deep learning (CXR). Researchers frequently use her CXR for imaging diagnostics. Several variables complicate chest radiograph interpretation, including patient positioning and inspiration depth. Based on Mask-RCNN, a deep neural network with global and local features for pixel-wise segmentation, our discriminative model can distinguish between different types of images. Our method accomplishes robustness by drastically altering the training procedure and adding a new post-processing phase that merges the bounding boxes of many models. Using a data set of chest X-rays reflecting possible causes of pneumonia, the proposed discriminative model is tested and does better.[10]

Abdullah Faqih Al Mubarok, Dominique Jeffrey, Ahmad Habbie Thias; "Pneumonia Detection with Deep Convolutional Architecture", 2019 - In this essay, we discover that pneumonia is a respiratory condition brought on by a lung air sac infection. In patients with pneumonia, there is fluid in the air sacs and alveolar inflammation. Radiologists can determine the presence of pneumonia using the intensity of chest X-rays. By giving radiologists a second opinion, computer-aided recognition (CAD) can help them become better diagnosticians. Deep convolutional architectures are one of the methods that can be used to develop CAD systems. This paper aims to investigate the classification and detection of pneumonia using two well-known Deep Convolutional Architectures, Residual Network and Mask-RCNN. Compare and assess the outcomes in addition.[12]

Herbert Bay, Tinne Tuytelaars, and Luc Van Gool, "SURF: Speeded Up Robust Features", Proceedings of the Alvey Vision Conference(PAVC), 2019 - In this paper, we introduce the SURF interest point detector and descriptor, a revolutionary scale- and rotation-invariant interest point detector (Speeded Up Robust Features). Regarding repeatability, uniqueness, and robustness, it comes close to or performs better than previously presented systems, but it can be computed and compared much more quickly. This is accomplished by employing integral images for image convolutions, building on the advantages of the best detectors and descriptors currently in use (in this case, using a detector based on a Hessian matrix and a descriptor based on a distribution), and simplifying these techniques to the core. As a result, several unique detection, description, and matching stages are combined. The study offers experimental findings on a typical assessment set and imagery gathered for a practical object identification application. Both demonstrate how well SURF performed.[15]

Zhang Huijuan, "Fast Image Matching Based-on Improved SURF Algorithm", Institute of Electrical and Electronics Engineers(IEEE), 2020 - To address the issues with the SURF (Speeded Up Robust Features) technique taking too long to match an image, a unique image matching algorithm to enhance surf will be presented in this work. This technique is built on the highly modified SURF feature descriptors to achieve a higher speed. We adopt the Fast-Hessian Detector of SURF for the FAST (Features from Accelerated Segment Test) corner detector to match an image. This research presents an improved surf to match a picture that can satisfy real-time demand and obtain a highly accurate computer result.[17]

Dong Hui, "Research of Image Matching Algorithm Based on Blob detection technique", International Conference on Computer Science and Information Processing (CSIP), 2021 - Blob location strategies concentrate on discovering regions that contrast in different properties, for example, brightness or shading, contrasted with encompassing locales, in a digital image. Blob is a locale of an image in which a few properties are steady or around consistent, and every one of the points in a blob can be considered to be like each other. The algorithm for the blob detection technique used by us is given below: This algorithm works by capturing the image from the webcam or any other camera in one of the given formats (e.g. MJPG_1280x720, MJPG_160x120).[18]

Luo Juan and Oubong Gwun, "SURF applied in Panorama Image Stitching", Institute of Electrical and Electronics Engineers(IEEE), 2021. This research proposes a panorama image stitching system that combines the multi-band blending image blending technique with the modified SURF image matching algorithm. The steps of the process are as follows: Using modified SURF, first obtain the feature descriptor of the image; subsequently, identify matching pairs; next, use K-NN (K-nearest neighbour) to check the neighbours; next, use RANSAC (Random Sample Consensus) to eliminate mismatch couples; finally, adjust the images using bundle adjustment and calculate the precise homography matrix. Lastly, use multi-band blending to combine photos.[16]

D. Varshni, K. Thakral, L. Agarwal, R. Nijhawan and A. Mittal, "Pneumonia Detection Using CNN based Feature Extraction, "IEEE International Conference on Electrical, Computer and Communication Technologies (ICECCT) 2019-To diagnose pneumonia in lungs, the medical practitioners use chest X-ray as the best imaging modality, and it can be managed effectively with medicines and proper treatment. The current system to detect pneumonia is not very précised. The main goal of the research paper is to provide a simple and effective algorithm for the localization of lung irregularities.[22]

Kundu R, Das R, Geem ZW, Han G-T, Sarkar R "Pneumonia detection in chest X-ray images using an ensemble of deep learning models." PLoS ONE 2021-Computer Aided Designs (CAD) have recently emerged as the principal machine learning study area. The CAD systems have already demonstrated their potential and value in the medical field, particularly in diagnosing lung nodules, breast cancer, and mammography early. Significant features have high relevance when using Machine Learning (ML) algorithms in medical images. Due to this, most earlier algorithms that developed CAD systems by analyzing photos used hand-crafted characteristics. The limits of the hand-crafted features, which varied depending on the assignment, prevented them from providing many useful functions. Convolutional neural networks (CNNs), in particular, were used in Deep Learning (DL) challenges that proved their ability to extract essential features [4, 24]. Transfer learning techniques, in which pre-trained CNN models learn the generic features on large datasets, are required for this feature-extraction procedure. Because many other conditions, such as congestive heart failure, lung scarring, etc., can mimic pneumonia, evaluating a chest X-ray in the case of pneumonia might not be accurate. This is the primary cause of the dataset's misclassification of the X-ray images. Differentiating between abnormal and normal chest X-rays is a challenging task.[19]

S. Shah, H. Mehta and P. Sonawane, "Pneumonia Detection Using Convolutional Neural Networks, "Third International Conference on Smart Systems and Inventive Technology (ICCSIT), 2020-For a variety of picture classification tasks, deep learning models, notably convolutional neural networks (CNNs), are widely utilized. Using this technique, a model trained on a large dataset is prepared for reusing, and the network weights generated in this model are applied to the problem at hand. For biomedical image classification tasks, CNN models are often used. These models were trained on big datasets like ImageNet, which contains over 14 million images. The framework's accuracy rate was 98.81% when tested on two datasets of chest X-rays for pneumonia made available to the public. By examining the different chest X-rays, it can be challenging to identify pneumonia in its early stages. One of the most popular deep learning neural networks is the convolutional neural network (CNN), which employs the max pooling layer and other layers. The layers aid in the X-rays' automated image recognition. It also includes the Rectified Linear Unit layer, often known as ReLU, which helps enhance non-linearity. It is a structure designed to handle 2D and 3D pictures successfully. It claims that the fixed network of trial-and-error systems is comparable in an aspect. The paper aims to identify patterns in patients and categorize them as having or not having pneumonia. To improve the performance, the dataset was additionally supplemented.[20]

III. RELATED WORK

We have explored algorithms such as Support Vector Machine(SVM), Image Segmentation, Image Matching-SURF and Convolutional Neural Networks(CNN). Let's look at each one briefly.

A. SVM(Support Vector Machine)

Classification and regression issues are resolved using a Support Vector Machine, or SVM, one of the most used supervised learning techniques. It is mainly used, nevertheless, in Machine Learning Classification problems. To swiftly assign future data points to the proper category, SVM determines the optimum decision boundary that divides n-dimensional space into classes.

Parameters of SVM:

Linear: When working with substantial sparse data vectors, it is helpful. It is frequently employed in text classification. Additionally, the splines kernel works well with regression issues.

RBF: It is a general-purpose kernel utilized when no prior knowledge of the data is available.

Polynomial: Used in image preprocessing.

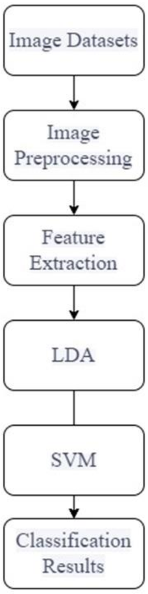

Fig.1.SVM technique architecture

B. Convolutional neural network

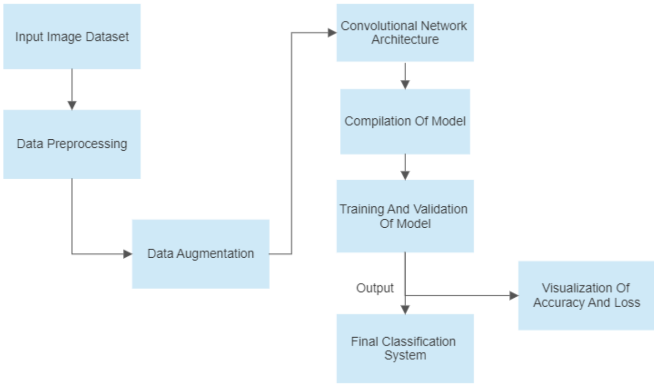

Fig.2.System Architecture

1. Techniques of data augmentation :

Rescale Normalization= Rescaling the image

Geometric Transformations = Transforming image into required dimensions.

Flipping=Ensures optimal performance of the model on the mirrored images; flipping is used to augment the data and provide flipped images.

Shearing= Used in obtaining sheared images to help the Deep Learning model for image sheared orientation

Rotation= helps in the rotation of the image, making the detection of pneumonia easy by distinguishing it.

2. Convolutional Neural Networks (CNN) is a class of deep neural networks used to analyze visual images. It consists of an input and output layer along with many hidden layers.

3. Performance Matrix For Validation Phase:

The accuracy of the system is calculated using the following formula.

$$\text{Accuracy} = TP + TN / \; TP + TN + FP + FN$$

TP=True Positive

TN=True Negative

FP= False Positive

FN= False Negative

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C. Image Matching-SURF technique

Many computer vision applications include determining the similarity between two photographs of the same scene or object. Examples are object identification, picture registration, 3D reconstruction, and camera calibration. This study aims to find discrete picture correspondences, which can be broken down into three primary parts. First, prominent areas in the image, such as corners, blobs, and T-junctions, are chosen as "interest spots."

Next, a feature vector depicts each interest point's surrounding area. This descriptor must stand out while resisting noise, detecting mistakes, and geometric and photometric distortions. The descriptor vectors are finally matched between several photos.

The objective is to create a detector and descriptor that computes faster than state-of-the-art models without compromising performance. To succeed, one must find a balance between the characteristics mentioned earlier, such as lowering the descriptor's dimension and complexity while maintaining a high level of distinctiveness.

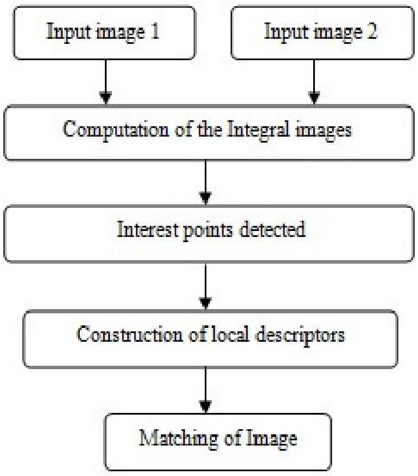

Fig.3.SURF technique architecture

D. Image Segmentation

The X-ray images that need to be classified as positive or negative for pneumonia must be converted to the necessary aspect ratio during preprocessing because the data comes in various image sizes. Because of the data imbalance, X-ray images need data enrichment. Expands the size of the positive class artificially. Analysis of an image's characteristics is referred to as classification. Based on the analysis, the dataset is further classified into two classes, regular and pneumonia-affected.

The created model is depicted in Fig. 4.1 after thoroughly analyzing the earlier publications. Class imbalance, or the fact that the data is biased more toward the negative class (X-ray images without pneumonitis) rather than the positive class, is a problem that needs to be addressed while developing the model. Initially, "the preprocessing" phase and "model architecture" were both intended solutions to the class imbalance issue. Since the data was composed of images of various sizes, the X-ray image that needs to be categorized as positive or negative for pneumonia during the preprocessing stage must be changed to the appropriate size/aspect ratio.

Given that the data is uneven, it is essential to artificially increase the size of the positive class in the X-Ray images (X-Ray images with pneumonia). The model must receive all the data at once. After examining the current setup, it was

determined that creating an ensemble of U-Nets utilizing ResNet-34 and EfficientNet-B4 would be the most effective solution to fix every issue.

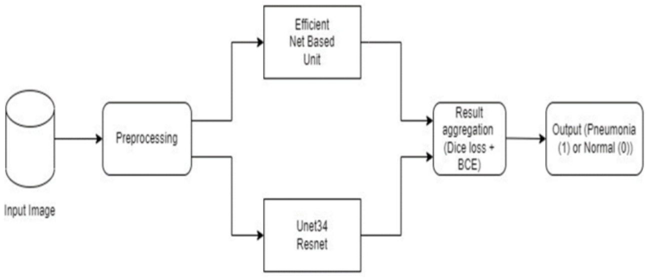

Fig.6. Model Architecture

IV. COMPARATIVE STUDY

Sr no	Title	Year/ Venue	Methodology	Strengths	Weakness
1	Computer-aided diagnosis of pulmonary infections using texture analysis and support vector machine classification. Authors: Jianhua Yao, Andrew Dwyer, Ronald M. Summers, Daniel J. Mollura	2020 (IEEE)	Texture analysis and support vector machine (SVM) classification were used to separate normal from abnormal lung regions in forty chests of computed tomography (CT) scans. These scans included ten cases of immunohistochemistry -proven infection, ten normal controls, and twenty cases of fibrosis.	This method may be used as a research tool in imaging tests to identify viral pneumonia.	Complexity
2	Convolutional neural networks for the Classification of Chest X-rays in the IoT Era Authors: Khaled Almezhghwi, Sertan Serte, Fadi Al-Turjman	2020 (PLOS)	Update the deep model designs to use a multi-class support vector machine classifier instead of the Soft-max function. For twelve chest X-ray disorders, the suggested AlexNet and VGGNet-based SVM provides average area under the curve values of 98% and 97%, respectively.	Higher accuracy of 97%	We can only use one dataset to compare the suggested methods with alternative methods.
3	A new approach for the detection of pneumonia in children using CXR images based on a real-time IoT system Authors : Joao Victor S.das Chagas , Roberto F. Ivo , Pedro P. Reboucas Filho	2021 (IRJET)	The suggested method comprised 84 combinations of pairs using 12 CNNs as extractors of picture attributes and seven traditional classifiers. The pairings of the extractor-classifier combination with accuracy, sensitivity, and precision values of more than 96.00% are	The time required for classifying per image is 5.7 microseconds.	There are 8.3 more photos utilized for training than for testing.

			highlighted.		
4.	Pneumonia Detection Using CNN-based Feature Extraction Authors: D. Varshni, K. Thakral, L. Agarwal, R. Nijhawan and A. Mittal	2019 (IEEE)	The preprocessing stage, the feature-extraction stage, and the classification stage are the three distinct stages that comprise the proposed model's architecture.	The computational complexity of the model	Only frontal chest X-rays were employed, despite evidence that lateral view chest X-rays can be just as useful for diagnosis.
5.	Pneumonia detection in chest X-ray images using an ensemble of deep learning models Authors: Kundu R, Das R, Geem ZW, Han G-T, Sarkar R	2021 (PLOS)	GoogLeNet, ResNet-18, and DenseNet-121 are three classifiers the author developed into an ensemble framework using a weighted average ensemble technique. The classifiers' weights were generated using a unique scheme.	Four standard assessment measures were utilized to assess the proposed ensemble approach on the two datasets for pneumonia.	The suggested ensemble must be trained using three CNN models, which increases the computing cost.
6.	Pneumonia Detection Using Convolutional Neural Networks (CNNs) Authors: S. Shah, H. Mehta and P. Sonawane	2020 (IEEE)	CNN models are feed-forward networks containing fully connected, flattened, pooling, and convolutional layers with appropriate activation functions.	The models in the study can be trained on larger datasets.	Complexity
7.	Pneumonia Detection Using X-Ray Authors: Keval Shah , Veer Patel, Indraneel Sarmalkar, Suchetadevi Gaikwad	2020 (IRJET)	In the First Step: choose an image as an input. In the Second Step: perform object recognition. In the Third step: CNN model with two convolutional layers. In the final step: The image is given as an input parameter to classify functions.	Accuracy of eighty-six. 86% (~90%).	Shorter datasets used
8.	SURF: Speeded Up Robust Features Authors: Herbert Bay, Tinne Tuytelaars, and Luc Van Gool	2020 (IEEE)	Uses integral images. Based on the Hessian matrix. Orientation based on dominant position. Uses 64 dimensions.	Accuracy of 85.7%,	Comparatively slower

9.	Fast Image Matching Based on Improved SURF Algorithm Author: Zhang Huijuan	2021 (IEEE)	The quick feature-based SURF technique to accomplish real-time matches on a computer. However, SURF has yet to achieve real-time performance; thus, to help SURF develop and meet the real-time requirement, we chose the FAST corner detector instead of the Fast-Hessian detector.	It offers a fresh approach to image matching and both viability and efficiency.	It lacks the scale-invariant characteristic.
10.	Research of Image Matching Algorithm Based on SURF Features Authors: Luo Juan and Oubong Gwun	2020 (PAVC)	Uses a balanced binary tree termed the KD tree. It contains two parameters: the first determines the set for which we want to create the KD tree, initially set as P; the second determines the depth of the subtree's root. The depth starts at zero.	The KD-tree method is unique because it increases the effectiveness of looking for comparable point pairs.	The input image must be turned into a grey image for image matching.
11.	Pneumonia Detection: An Efficient Approach Using Deep Learning Authors: Ayush Pant, Akshat Jain, Kiran C Nayak, Daksh Gandhi, B. G. Prasad	2020 (IEEE)	This project aims to construct an AI network that performs linear operations and activations on each pixel value received as input for a given X-Ray image. Then, after multiplying each operation by the number of nodes and each layer in the neural network, the result is obtained.	Tackles the issue of noise in the image.	High recall but low precision
12.	Identifying pneumonia in chest X-rays: A deep learning approach Authors: Amit Kumar Jaiswal, Prayag Tiwari, Sachin Kumar, Deepak Gupta, Ashish Khanna, Joel Rodrigues	2019 (IRJET)	Vector quantization and regression neural networks have been used to study chest disease. Another study used neural networks to analyze chronic pneumonia disease and to make a diagnosis. In a different study, lung	Has a high precision value.	A thorough study is necessary to make accurate and trustworthy predictions using the power of deep learning

			diseases were identified using chest radiographic images. Histogram equalization was used for image preprocessing, and a feed-forward neural network was used later for classification.		across thousands of patient samples.
13.	Pneumonia Detection with Deep Convolutional Architecture Authors: Abdullah Faqih Al Mubarok, Dominique Jeffrey, Ahmad Habbie Thias	2019 (PLOS)	Radiography techniques like CT scans and MRIs can be used to identify pneumonia. Since soft tissue is X-ray permeable, it will appear black on radiographs. Bright colour is produced when X-ray intensity is reduced on hard tissues, such as bones. Numerous anomalies, including cancer cells, could be the reason for the brighter colour in the lung cavity.	Produces the highest reported accuracy rates.	Improving local contrast is necessary before classifying details to obtain a more precise segmentation.

V. CONCLUSION

In this study, we tried to explore various deep learning algorithms such as Support Vector Machine(SVM), Image Segmentation, Image Matching-SURF and Convolutional Neural Networks(CNN). We did a comparative study based on their classification accuracy for pneumonia detection. In the overall study, we observed that Convolutional Neural Networks(CNN) and SURF technique is superior to other methods in accuracy and precision.

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