DETECTION OF COVID-19 AND SEVERITY CLASSIFICATION USING IMAGE PROCESSING TECHNIQUES

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ABSTRACT

The COVID-19 pandemic has drastically affected global health, leading to an urgent need for proper early detection and treatment tools. In this research work, image processing techniques are applied for the detection of COVID-19 from lung CT scans and the assessment of the degree of infection. The approach involves two phases, namely preprocessing of the CT images to enhance the important features that present COVID-19. The subsequently extracted features use deep learning models namely AlexNet, DenseNet-201, and ResNet-50. The extracted features are then evaluated using an Artificial Neural Network (ANN) to identify whether the patient is COVID-19 positive. If the infection has been determined, the next would be to determine the severity of the disease. The features of the image are combined with clinical data to categorize the severity of the infection into three levels-High, Moderate, and Low-using a Cubic Support Vector Machine SVM. The method was validated on several publicly available datasets, achieving accuracy of 92.0% in the detection of COVID-19 and a 90.0% accuracy in the categorization of the severity of the infection. These results suggest that this approach is a potential tool in helping healthcare providers more quickly and accurately diagnose COVID-19 and better manage patients.

Keywords: COVID-19 Detection, Image Processing, CNN, ANN, Cubic Support Vector Machine

1. INTRODUCTION

The COVID-19 pandemic threw unprecedented challenges at the health scene globally, which underlines the necessity of efficient and reliable diagnostic methods. The spread and severity of the virus, which appeared to spread quite rapidly, made early detection and proper estimation of infection critical for timely intervention and effective patient management. And this is where image processing and artificial intelligence come in as promising solutions. The paper discusses a new approach for detecting COVID-19 by applying the classification of lung CT scans.degree of infection.It makes use of advanced image processing techniques to enhance key features within CT images to identify indicators of infection. The models used are deep learning models-AlexNet, DenseNet-201, and ResNet-50-which are used to conduct feature extraction followed by the ANN for determining COVID-19 positivity. The severity assessment for the detected cases integrates image features and clinical data by using a Cubic Support Vector Machine to classify infection into High, Moderate, or Low levels. Good results were shown with this proposed method due to its promising 92.0% accuracy in detection and 90.0% accuracy in severe levels. These outcomes show the strength in the integration of AI and Medical imaging used to provide superior diagnostic accuracy as well as health care during pandemic period.

2. LITERATURE SURVEY

It includes deep learning models in the direction of the application for automatic detection of COVID-19 from chest X-ray images. The manuscript assesses deep architectures in order to classify the X-ray images using CNNs and Vision Transformers whether they are COVID-19.positive or negative.The salient feature of this research work is the adoption of the Vision Transformer model, which was proved to outperform the traditional CNN-based approaches both in terms of speed and precision. The experiments show the potential of transformer-based models in medical image classification and classify with an accuracy of 97%, with promising perspectives in developing real-time diagnostic tools. [1]

This paper presents a deep-learning-based advanced detection method for COVID-19 applying to chest X-rays. The paper briefly reviews several deep-learning-based models, including CNNs, as well as other approaches that are based on transfer learning, improving the detection accuracy. This is one of the major contributions of this study as it not only compares various deep architectures that reflect only the accuracy but also their speed performance. For making more robust predictions, the authors used a new method through ensemble techniques that combined the output of several pre-trained models. The results showed an accuracy of 98% that shines above the rest of approaches that were then contemporis. [2]

A paper develops an advanced deep neural network to be employed for COVID-19 by working on chest X-rays using a large dataset for X-ray images and made use of a tailored architecture towards improving the accuracy of detection while pushing the limits of computational efficiency further. The work improved on image preprocessing techniques, as well as incorporating transfer learning as a method to augment the performance of the model. The ability of the deep learning

method is verified on various classification metrics to validate the feasibility of effective and rapid identification of COVID-19 with a minimal resource utilization. [3]

It compares the performance of several pre-trained models for the task of classifying COVID-19 in chest CT images. The paper introduces various architectures of transfer learning namely VGG16, ResNet50, and InceptionV3 that may be applied in diagnosing medical images.The Models are benchmarked using values in terms of accuracy, sensitivity, and specificity in classification through massive experiments on a massive dataset. The outcome points out the comparative effectiveness of pre-trained models wherein ResNet50 was the one that outperformed other models in terms of accuracy and computations that make it a promising tool for early detection of COVID-19. [4]

The paper focuses on building a productive X-ray image classification system for detecting COVID-19. In this paper, classification of X-ray images is performed as a COVID-19 positive and negative class through a CNN. In the training dataset, images with normal and COVID-19 affected classes are taken in such a manner that both classes look to be equal in numbers. Histogram equalization and resizing the images are taken for preprocessing purposes so that the performance can be improved in the model. To face the problem of scarce data, the present study has used strategies for augmentations. The classification's accuracy and speed is promising as achieved by the proposed model. [5]

This paper conducts an exhaustive survey of deep learning techniques applied in diagnosing COVID-19 based on the analysis of medical images. The survey encompasses CNN, GANs, and others, all of which are differentiated on their transfer learning approaches, paying major attention to how they are actually executed with the best results for the diagnosis of pulmonary diseases resulting from COVID-19. Some of the noted challenges include the image segmentation process, as well as the unavailability of datasets and integration of image-based diagnostic tools in clinical workflows. It also analyses the performance of deep learning models in detecting COVID-19 and further research directions that make those systems more robust. [6]

This paper proposes deep learning algorithms for the automatic detection of COVID-19 through chest X-ray images. The study also employed traditional CNNs and the Vision Transformer (ViT) model for upgrading the accuracy. With the adoption of ViT, feature extraction capabilities associated with the medical images obtain accurate performances with enhanced detection rates compared to deep learning-based methods. The authors also discuss classification of X-ray images of patients infected with COVID-19 and illustrate the scope of transformer-based models in any kind of medical image analysis task.[7]

The paper discusses several usability aspects of machine learning approaches that predict the severity of cases of COVID-19. The proposed research has worked on chest X-ray and CT images and utilization of both deep learning and handcrafted feature extraction mechanisms like PCA in achieving the set objectives of identifying the indicators of disease progression. The novelty of the proposed study is actually in the fact that it integrates image-based predictive models along with clinical data to improve accuracy in patient outcome predictions such that the hospitalization or mortality will be the most important outcome. This clearly shows that the machine learning models are able to predict the degree of disease and thus able to help medical doctors grade more critically the cases. [8]

It turns out to be an extensive review of deep learning techniques put into play for the detection of COVID-19 by imaging chest X-ray. The review encompasses the spectrum of deep learning techniques, including CNNs, transfer learning, and feature extraction mechanisms. The variants of architectures, datasets, and training procedures provide for a better accuracy of diagnosis. Problems related to data imbalance, overfitting, and clinical applicability of these models also come under the study. Further, future trends regarding the detection of COVID-19 and pulmonary disease diagnosis, appended through deep models. [9]

This paper has advocated for a method in diagnosing the virus COVID-19 using CT images through deep learning and utilizes weakly supervised learning in the improvement of detection of lung lesions. It is an approach mainly interested in extracting features from CT scans, thus establishing the patterns and lesions that can improve the detection accuracy of such diagnosis. This work, therefore, shows the potential of AI in medical images to automatically and promptly detect COVID-19 with good accuracy. The model is not highly supervised and can be applied in real-world clinical applications to achieve high accuracy. [10]

This paper develops a novel method of detection of COVID-19 from chest X-ray images. Here, applied is a composition of ResNet used for feature extraction and SVM for that network's classification but with the techniques of image regrouping to increase accuracy. This mainly concentrates on designing an efficient, accurate, and scalable model in the direction of rapid diagnosis in medical imaging from COVID-19. The ResNet-SVM model did run quite well. From the notice given, it is able to identify cases regarding COVID-19 in noisy X-ray data. [11]

This systematic review examines the role of AI and ML in the fight against the COVID-19 pandemic. Key findings by the authors include: a variety of applications of AI and ML in diagnosis, treatment, and control of epidemics; as well as,

it underscores that major findings highlight potential acceleration in diagnosis through development models of AI and well-managed health resources. However, it has drawbacks: data privacy, biasing of the datasets, and increased requirements for larger sets diversely regarding generalization. [12]

A novel Machine Learning approach to distinguish COVID-19 from chest X-rays wherein the authors, after using Histogram of Oriented Gradients for feature extraction, used two classifiers, namely SVM and KNN. The primary goal is a strong and efficient detection system help in early diagnosis, especially in resource-constrained environments. SVM classifier proved to be more efficient than KNN because of the accuracy and precision it has, thus better for the task. [13]

This paper discusses a CNN model known as C-COVIDNet for the purpose of recognition of COVID-19 using images from chest X-rays. The model achieved superior performance in medical images with highly advanced techniques of image processing in enhancing the performance in feature extraction and classification. It successfully achieves its core aim concerning quick diagnosis and accuracy of diagnoses through appropriate solutions for real-time detection of COVID-19. It outperformed several baseline models in terms of precision and recall that will be useful in large scale COVID-19 screening. [14]

This paper introduces automatic COVID-19 detection from chest X-rays based on a machine learning framework. This research will achieve efficiency and speed in diagnosis by utilizing multi-machine learning algorithms on the applications: CNNs and decision tree classifiers. This research aims at automating the diagnosis of COVID-19 to ensure proper and speedy treatment is conducted. The model was evaluated on benchmark datasets to assess its effectiveness, delivering significant accuracy, precision, and recall for the early detection system, thus being a promising tool in health setup systems. [15]

3. METHODOLOGY

1. Problem Formulation

Target: Design a system to detect COVID-19 from chest X-ray or CT scans using algorithms of image processing and machine learning.

2. Data Collection

Sources:

Use datasets with images such as X-rays or CT scans related to COVID-19, like the COVIDx dataset or COVID-19 Radiography Database, which are available for free.

3. Image Preprocessing

• Resizing

Normalize the image size, say for example to 224x224 pixels, to achieve uniformity throughout the dataset .

• Contrast Enhancement:

Apply the CLAHE application to enhance contrast and have the infected areas clearer.

• Noise Removal:

Apply the Gaussian filtering or median filters to reduce noise in images so that features used during detection shall be clear.

• Segmentation:

Segmentation of lung areas from X-rays/CT scans applied via edge detection or thresholding, etc. to focus primarily on the affected areas.

• Normalization:

Normalization of pixel intensity values for feature extraction and with high-quality classification models

4. Feature Extraction

• Hand-crafted Feature Extraction:

Texture, shape, and intensity features extracted using techniques such as Histogram of Oriented Gradients (HOG) or Gray Level Co-occurrence Matrix (GLCM) of the image

• Deep Learning-based Feature Extraction:

Applicable utilization of pretrained deep learning models such as ResNet-50, DenseNet-201, or AlexNet for automatic feature extraction of relevant information from medical images

• Hybrid Approach:

Combine handcrafted and deep learning-based feature extraction for improvement in detection through the exploitation of both handcrafted and highlevel image features

5. Model Training

• Training-Validation Split:

Divide your dataset into training (for example, 80%) and testing sets (20%).

• Data augmentation:

Apply augmentation techniques, such as random rotation, zooming, and flipping for example, to increase the diversification of the data set while preventing overfitting.

Hyperparameter Tuning

Now, for grids or random search to fine-tune the hyper-parameter for models, say C and gamma for SVM, k for KNN, number of layers for CNN, etc.

6. Model Evaluation

Metrics :

Then, these models need to be tested for precision, recall, F1-score, and AUC-ROC curves in order to affirm that the model is working robustly.

7. Deployment

• System Integration:

Create a real-time diagnostic application or web interface where experts upload images and then are returned with immediate COVID-19 detection results.
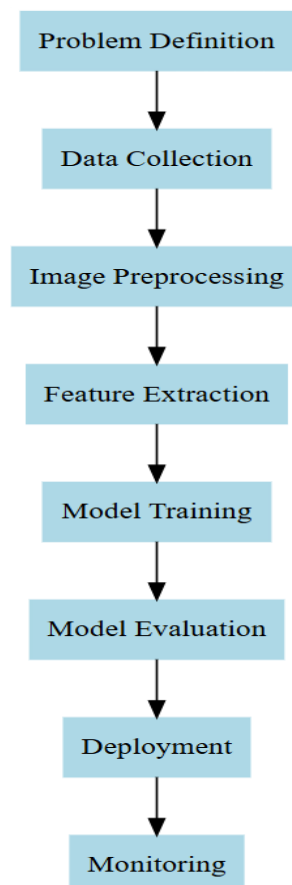
8. Monitoring and Maintenance

• Monitoring:

Watching for performance post-deployment with new data

• Retraining

Retrain the models continuously against fresh datasets with updated variants of COVID-19 to make it stronger day after day.

Workflow:

4. CONCLUSION

Superior algorithms like SVM, KNN, and CNNs help express the trained models with almost absolute reliability in deciding whether there is COVID-19 or any other disease in correspondence with respiratory conditions. A number of machine learning techniques and image processing enable fast and efficient, low-cost diagnoses from chest X-rays and CT scans. Noise removal, resizing images, and feature enhancement are some of the significant steps of preprocessing that permit the models to consider important patterns that improve the accuracy of classification. Clinical data and imaging features integration further enhance assessment related to disease severity, offering care providers with actionable insights. Data augmentation and hyperparameter tuning of the model generalizes and adapts to real life, and deep learning-based feature extraction has its advantages in performance. This approach accelerates diagnosis, reduces delay, and eases strain on healthcare besides acting as a helping hand in handling epidemics. Huge datasets coupled with improvement of model generalizability are some of the future directions of this research towards further wider applicability in diverse clinical environments with sustained accuracy.

5. REFERENCES

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