

A Deep Learning Neural Network Techniques in Visualization, Imaging Data Acquisition And Diagnosis for Covid-19

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Abstract: The corona virus disease pandemic of 2019 (COVID-19) is sweeping the globe. Medical imaging, such as X-ray and computed tomography (CT), is critical in the global fight against COVID-19, and recently evolving artificial intelligence (AI) technologies are enhancing the capacity of imaging tools and assisting medical specialists. For example, image acquisition driven by Deep Learning Architecture may help optimise the scanning process and reshape the workflow with minimal patient intervention, ensuring the best security for imaging technicians. Furthermore, computer-aided platforms assist radiologists in making clinical decisions, such as disease identification, surveillance, and prognosis. In this workflow, we cover the full range of COVID-19-related medical imaging and analysis techniques, including image processing, segmentation, diagnosis, and follow-up. Traditional methods are used to interpret the evaluation, and various output metrics are collected.

Keywords: CT, X-ray, Covid-19

1. Introduction

1.1 Digital Image Processing

The field of digital image processing includes the use of a digital machine to process digital images. A digital image is made up of a certain number of elements known as picture elements, image elements, pels, or pixels. The most common term for the basic element of a digital image is pixel. Digital imaging technologies, like human imaging systems, can capture digital images and archive them for later processing. However, unlike humans, which can only capture images in the visible band of the electromagnetic spectrum, imaging devices can capture images across the entire spectrum. As a result, digital image processing has a broad range of applications in fields such as medicine, remote sensing, traffic control, record analysis and retrieval, and so on.

Computer Vision, on the other hand, is a research domain whose ultimate goal is to use computer systems to mimic human vision by learning from the environment and being able to make inferences about real circumstances and taking appropriate actions based on those inferences. Another branch of expertise in this field is Artificial Intelligence (AI), which aims to mimic human intelligence. Image Analysis or Image Understanding is a field that sits somewhere between image processing and computer vision. The scientific community is divided about where the line between image processing, image analysis, and computer vision should be drawn. Image processing is often defined as a discipline in which images serve as both the input and output of the process. It's a procedure that includes basic operations like noise reduction, contrast enhancement, and image sharpening, among others. Image analysis is a method in which the inputs are typically images, but the outputs are usually attributes derived from those images (e.g., edges, contours, and the identity of individual objects). Finally, computer vision can be described as a process that entails "making sense" of a group of recognised objects, such as in image analysis, as well as performing cognitive functions normally associated with vision. The field of identification of individual regions or artefacts within an image appears to be a reasonable place of convergence between image processing and image analysis, based on the preceding discussions. In a wider context, digital image processing includes processes that use images as inputs and outputs, as well as processes that extract attributes from images, up to and including object recognition. Consider the issue of automatic text recognition inside a general scene picture to further explain the idea. The processes of obtaining a text-containing image, pre-processing the image, segmenting the individual characters, defining the characters in the form of feature values appropriate for computer processing, and recognising those individual characters all fall under the umbrella of digital image processing. Depending on the degree of complexity of the problem corresponding to the level of expected solution indicated by the expression "making sense," making sense of the content of the image may be considered image processing or even computer vision.

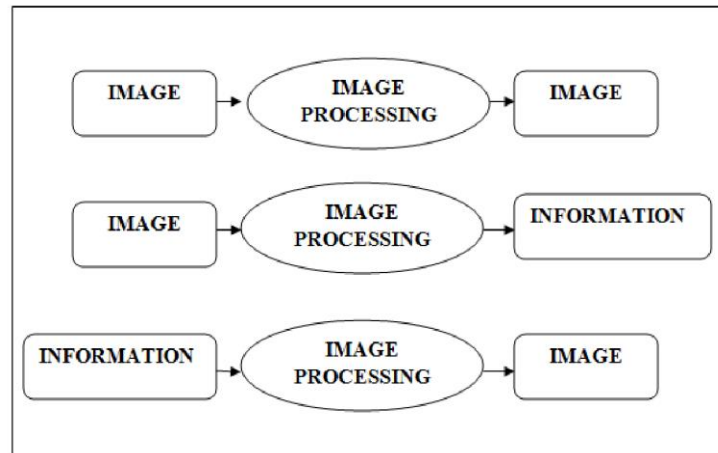


Figure1 Transformation in Image Processing

1.1.1 Image enhancement

Image enhancement is a technique for making image effects clearer by enhancing original images so that they are better suited for display or further image analysis. It aids in the removal of noise, sharpening, and brightening of images, allowing key features to be easily identified. The Discrete Fourier Transform is used to perform the 2-Dimensional convolution in the frequency domain.

1.1.2 Image restoration

Image restoration is a technique that allows you to restore a clear image from a degraded or corrupted image. Photos that are corrupted or blurred are caused by noise, distortion, or camera misfocus. Blurring occurs when an ideal image's bandwidth is reduced due to an incomplete image forming process. As a result, by reducing physical deterioration, the photographs can be returned to their original condition.

Model of degradation: Distortion is caused by flaws in the imaging system, which are most noticeable in stored images. Because of the random noise in the imaging system, this issue becomes serious. The degradation operation reduces the size of a degraded image g by working on the input image $f(x, y)$ (x, y).

1.1.3 Image compression

Picture compression is the method of reducing the size of an image file's bytes without compromising image quality in order to produce a clearer image. More images may be stored in a given amount of disc or memory space due to the smaller file size. It also cuts down on the time it takes to transfer photos across networks or import them from websites.

1.1.4 Image segmentation:

For the purpose of image analysis, segmenting or partitioning the original image with some identified pixels into a number of regions depicts the features concealed in the normal image, such as object recognition, unknown boundary estimation, textures, and motions. Segmentation is carried out based on the image's area and edges.

1.1.5 Image Recognition

The technique of image recognition entails recognising, distinguishing, and detecting features in video or photographs, such as objects. During the recognition mechanism, images from the database are compared to the current image, and if a match is identified, the process is then performed in real time. It aids in the process of authentication and authorization.

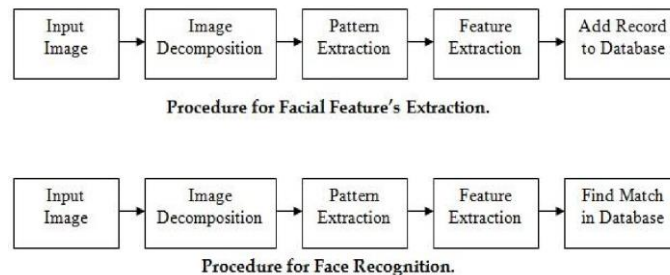


Figure. 2 Image Recognition Process

1.1.6 Image smoothing

The image's noise can be minimised using this smoothing technique. This smoothing technique, which acts as a filter, removes noisy data such as dots, blur, speckles, and stains from an image. It's successful. Based on the low pass filter, averaging nearby pixel values helps to reduce the large difference between pixel values. Using a single value for an image, such as the median or average value.

Smoothing operations

- Linear filter
- Non-Linear filter

1.2 Applications of Digital Image Processing

Digital image processing has a long history of implementations, dating back to the early twentieth century. Sending pictures by submarine cable between London and New York is one of the earliest uses of digital images, according to literature. The Bartlane cable picture transmission system was introduced in 1920, which reduced the time it took to move a picture across the Atlantic. The images were coded for cable transmission using specialised printing equipment, and the images were then reconstructed at the receiving end. By the end of 1921, the visual quality of these early digital photographs had been improved thanks to the introduction of a technique focused on photographic reproduction. The early Bartlane systems could code images in five different grey levels, which was later increased to 15 in 1929. Despite the fact that the examples above include digital images, the evolution of digital image processing is inextricably linked to the evolution of the digital machine. Since digital images need so much storage space and computing power by their very design, progress in the field of digital image processing has been heavily reliant on the development of digital computers. Though the concept of a computer has been around for a long time, it wasn't until the 1940s that John von Neumann introduced two main concepts: (1) a memory to store a stored programme and data, and (2) conditional branching. These two principles form the basis of a central processing unit (CPU), which is at the core of today's computers. From Bell Laboratories' invention of the transistor in 1948 to the present use of ultra large scale integration (ULSI) in the 1980s, a sequence of key developments led to computers powerful enough to be used for digital image processing, starting with the von Neumann architecture. The first computers capable of carrying out meaningful image processing tasks appeared in the early 1960s, and the first potential digital image processing using those computers for improving images from a space probe began in 1964 at the Jet Propulsion Laboratory in California, when images of the moon transmitted by Ranger 7 were processed by a computer to correct various types of image distortions. One of the most significant events in the application of image processing in medical science was the advent of computed tomography (CT) in the early 1970s. Image registration, which is the method of aligning two or more images (the reference and sensed images) of the same scene taken at different times, from different perspectives, and/or by different sensors, is another emerging area of application. This has a number of uses in the medical sector and other areas. The field of image processing has developed steadily from the 1960s to the present day.

Digital image processing techniques are also used in a wide variety of fields, in addition to medicine and space programmes. Another application of image processing is the study of aerial and satellite imagery. Image processing methods are used in physics and related fields to boost the effects of experiments in areas such as high-energy plasmas and electron microscopy. Restoration of distorted photographs that were the only available records of rare artefacts missing or destroyed after being photographed is one example of archaeology's use of image processing. Bioinformatics, astronomy, chemistry, nuclear medicine, law enforcement, defence, and industrial applications are all examples of active image processing applications. The preceding examples demonstrate situations in which the processing results are intended for human interpretation. Another important field in which digital image processing techniques are used is to solve problems involving machine perception, which may bear no resemblance to the visual features that humans use to view image material. Biometric recognition is a significant and wide application field in which digital image processing is crucial. The well-researched areas in this domain include automatic face recognition, fingerprint recognition, palm recognition, and retina recognition. Another area of research is content-based image retrieval, in which images are categorised and indexed based on their content, allowing the desired class of images to be retrieved if and when required in the future. The lexical sense of arm/body movement and facial expression is analysed in sign language and attitude analysis, and high level semantics are inferred. Optical character recognition (OCR), robotics, military signal processing, meteorology, and environmental assessment are all examples of machine perception applications that use image processing techniques.

1.3 Artificial Intelligence:

Artificial intelligence (AI) is a branch of computer science that studies computational problem-solving models of problems that are close in complexity to those solved by humans. Artificial Intelligence is the study of how to programme machines to perform tasks that humans currently perform better. It is machine intelligence and the branch of computer science that aims to develop it. The research and creation of intelligent agents is also named as Artificial Intelligence. Reasoning, intelligence, preparation, learning, communication, awareness, and the ability to move and control objects are all core AI issues.

Problem-solving skill is a hallmark of intelligence. Consider a mouse attempting to locate the piece of cheese in the image's right top corner. The mouse can discover several solutions to this problem. We may assume that the mouse is intelligent enough to solve the problem. As a result, the capacity to solve problems reflects knowledge. Intelligence is the computational aspect of the ability to accomplish goals in the world; humans, many animals, and certain machines all have varying degrees of intelligence.

Artificial Intelligence (AI) is a fusion of computer science, physiology, and philosophy. AI is a broad subject that encompasses a variety of areas, ranging from computer vision to expert systems. The development of machines that can "think" is a theme that runs across all AI fields. Building structures that replicate the behaviour of the human brain, which is made up of billions of neurons and is arguably the most complex matter in the universe, is one of the most difficult challenges facing experts.

Artificial Intelligence (robotics) today has the ability to mimic human intelligence by performing a variety of tasks that involve thought and learning, as well as solving problems and making decisions. Artificial intelligence applications or programmes are introduced into machines, computers, or other devices to give them the ability to think. However, much of today's Artificial Intelligence (robotics) is still up for discussion, as further research into how they solve tasks is needed. As a result, Artificial Intelligence devices or systems should be capable of performing the necessary tasks without making mistakes. Furthermore, robotics should be capable of performing a number of tasks without the need for human interaction or power. Today's artificial intelligence, such as robotic vehicles, is quickly evolving with high performance capabilities such as traffic control and speed minimization, allowing it to advance from self-driving cars to the SIRI. The current emphasis on presenting artificial intelligence in robots in order to achieve human-like characteristics significantly increases human reliance on technology. From cancer care to ensuring food protection for an expanding population to analysing climate change, AI offers significant solutions to society's problems. It's crucial in strategic games like poker and chess, where the machine chooses between a large number of possible positions based on heuristic expertise. AI enables interactions with a machine that recognises natural languages spoken by humans. Speech Recognition is another significant AI feature that can recognise different accents, background noise, and changes in the user's voice due to cold, among other things. Fraud detection is one of AI's most significant applications. Mastercard, for example, employs intelligent decision technology to evaluate various data points in order to detect fraud, improve real-time accuracy, and reduce false declines. Handwritten text can be analysed by AI

programmes, which can recognise letter shapes and convert them into editable text. Visual models analyse and comprehend machine visual input. Face recognition systems and specialist systems to diagnose patients are examples of such systems. Robotics is an AI programme in which robots can perform tasks that humans can't. In hospitals, ANN is used as a decision-supporting device in the diagnostic process, similar to how idea processing technology is used in EMR software. HR and recruitment professionals use AI in three ways: scanning applicants and their applications, using career matching platforms to forecast applicant performance in specific positions, and automating routine contact tasks. Telecommunication companies use heuristic search in the management of their workforces. Fuzzy logic controllers have been developed for automatic gearboxes in automobiles. Artificial intelligence and sensor technology are used to build home water quality control applications. Popular AI applications include Netflix and Amazon, where user habits are evaluated and compared to others to determine which shows or items to recommend using machine learning algorithms. AEG (Automatic Exploit Generation) is a bot that identifies a software flaw that results in security issues. Artificial intelligence aims to clarify all aspects of human intelligence through a computation mechanism. It has the ability to communicate with the world through the use of sensors and make decisions without the need for human interference. Artificial intelligence (AI) can be described as "manufactured thought." Intelligence is a distinct property or attribute that can be differentiated from all other characteristics of a person. Artificial Intelligence can also be seen in the actions taken or the ability to accomplish complex tasks. Classical AI, also known as symbolic AI, is the oldest approach to artificial intelligence. It is predicted in these early approaches that any process involving either a human or a computer can be expressed by symbols that are adjustable according to a set of predefined laws. AI is usually used to describe the experimental or theoretical applications of a computer's ability to act like a person. Artificial intelligence is usually divided into two categories: strong AI and weak AI. A machine with strong Artificial Intelligence is one that can solve problems on its own. Modern working systems are good examples of artificial intelligence that isn't so good. Artificial Intelligence is only effective when it makes societal contributions. Using both the principle of image processing and AI algorithms, AI has elevated credit scoring to a new level, allowing for automation, high accuracy, and speed.

1. Artificial intelligence algorithms are used to optimise the management of financial assets.
2. AI is used as a spy in the financial sector to combat bribery and money laundering.
3. Artificial intelligence is used to identify and select financial data, which is then presented in reports, blogs, newsletters, and posts.
4. Artificial intelligence may also be used in an effort to improve customer service.

1.3.1 Importance Of Artificial Intelligence

Artificial Intelligence, as a revolutionary development factor that can drive company performance, can revolutionise the way various businesses operate and expand around the world. To take advantage of AI's potential, the majority of companies around the world are actively developing various Artificial Intelligence strategies. They should also concentrate on designing responsible AI programmes that are consistent with ethical and moral principles, resulting in constructive reviews and empowering people to do what they do best, which is creativity. Many industries across the world will benefit from improved profitability and also expect economic growth as a result of successfully applied Artificial Intelligence (AI) solutions. To take advantage of this opportunity, the study describes eight strategies for effective AI implementation, all of which concentrate on taking a human-centered approach and taking creative and responsible steps for the application of technology to businesses and organisations around the world. The existence of symbolic constructs, their capacity to demand, and the existence of intelligence are all prerequisites for the construction of intelligent machines in various industries (raw material). When artificial intelligence reaches a level of intelligence equal to or greater than that of humans, political and social change will eventually occur, with AI reaping all of the benefits once it knows it does not require humans to colonise the universe. With its 486 processors, a recent breakthrough in artificial intelligence portrays orbiting communications satellites in space. Self-replicating artificial intelligence may be easily created for all human colonies outside the world in the future, and the human race would never be able to compete on an equal footing in space.

2. Related Works

2.1 Diagnosis of Diseases in Brain

(Feng Shi et al. 2020) , Survey examines how AI provides secure, accurate and effective imaging solutions Enquiries for COVID-19. The entire pipeline of AI-empowered imaging technologies is covered in depth in COVID-

19, which includes intelligent imaging systems, clinical diagnosis, and groundbreaking science. It is indeed important to keep in mind that imaging only gives you a partial picture of COVID-19 patients.

(Agrawal Richa, 2013), Since the increased need for effective and objective assessment of large volumes of data, medical image research for brain tumour detection has piqued interest. Tumors, also known as neoplasms in medical terms, are an irregular mass of tissue that develops as a result of uncontrolled cell division or proliferation in the human body.

2.2 Diagnosis of Diseases in Breast

(Mostafa Langarizadeh and Rozi Mahmud, 2012) According to the report, women with dense breasts have a higher risk of cancer on mammograms than those with less dense breasts. The presence of glandular cells in the breast parenchyma causes this. As a result, radiologists must pay particular attention to denser breasts in order to identify anomalies. Kurtosis, skewness, median, and mean are some of the statistical parameters that are used in the proposed process. The system was tested on 180 mammogram images and found to be 92.8 percent accurate, with a good connection between the system's estimate and that of radiologists ($K=0.87$, $p=0.0001$).

(Maitra Indra Kanta et al. 2011) on the job Mammography is currently one of the available methods for early detection of masses or anomalies associated with breast cancer, according to the report. Masses and calcifications are the most common anomalies that may signify breast cancer. The optical mammogram image is used to detect breast cancer at an advanced point. A method for creating a supporting tool has been introduced in this paper.

2.3 Study of Digital Image and Remote Sensing

(Matthias Kirchner and Jessica Fridrich 2011) It is commonly recognised in digital image forensics that deliberate manipulations of image content are the most important, and as a result, many forensic approaches concentrate on detecting such "malicious" post-processing. The researcher demonstrated a simple but effective method for detecting median filtering, a popular de-noising and smoothing operator in digital images.

(Tiwari R.B. 2011) The study suggests that instead of the methods described in, the LoG filter be used for the contrast improvement procedure. The Laplacian-of-a-Gaussian (LoG) Filter is suggested as an adaptive technique for improving the contrast quality of dental X-ray images. LoG Filter has a biological profile that is similar to the response of the receptive fields in the Human Visual System (HVS).

(Joshi Sneha K. 2014) The study is focused on a digital image analysis of the composition of a concrete mixture. The concrete is made up of different types of cement, air voids, and aggregates. X-ray CT images are used to analyse the compositions of the concrete mixture. The image is processed using a digital image processing algorithm. The collected image is analysed and filtered using this Digital image processing algorithm. To evaluate absolute errors, the resultant image is compared to the X-ray CT image, and the observed and projected mixture proportions are compared. Aggregates, cement products, and air voids all have T1 and T2 threshold ranges.

(Devis Tuia and Gustavo Camps-Valls, 2014), The research is focused on techniques developed in the field, which allow for a wide range of real-world applications with significant societal impact. Urban surveillance, fire detection, and flood prediction, for example, may have a major effect on economic and environmental issues. All of the applications are approached through basic formalisms in machine learning and signal/image processing, such as classification and clustering, regression and function approximation, image coding, reconstruction and enhancement, source unmixing, data fusion, or feature selection and extraction.

2.4 Diagnosis of X-ray in dental care

(PO-Whei Huang et al, 2014) The research focuses on the technique of tooth isolation. For bitewing dental X-ray pictures, this study highlights a highly efficient and completely automated tooth isolation process. The upper-lower

jaw separation process, according to their research, is focused on gray-scale integral projection to prevent information loss and includes angle adjustment to handle distorted images. The study suggests an adaptive windowing scheme for identifying gap valleys in single tooth isolation to increase accuracy.

(Reddy M.V. Bramhananda et al.2018) Their research focuses on the classification of dental caries, which is critical for the diagnosis and treatment preparation of a dental disorder that affects a significant number of people around the world. It may also be used to perform in-depth studies and inquiries into the essence of dental disease. Dental caries is clearly apparent in x-ray changes and can be observed in radiographs by the presence of a caries lesion.

Author	Year	Concept	Merits	Demerits
Feng Shi et al.	2020	This paper discusses how AI-empowered image acquisition can significantly help automate the scanning procedure and also reshape the workflow with minimal contact to patients, providing the best protection to the imaging technicians.	AI can improve work efficiency by accurate delineation of infections in X-ray and CT images, facilitating subsequent quantification.	Imaging only provides partial information about patients with COVID-19
MostafaLangarizadeh and Rozi Mahmud	2012	Using digital mammogram images, this paper will investigate a novel quantitative approach for categorising breast density.	The percentage of breast density obtained is more precise than other methods of determining breast density.	The best criterion is the difference between the median and mean, but when there are some lesions, some error may occur.
MaitraIndraKanta et al.	2011	In order to detect the development of breast cancer in women, digital mammograms are used.	In women who have no symptoms, mammography detects around 80%-90 percent of breast cancers.	Mammography is a highly reliable test, but it isn't flawless, like most diagnostic tests.
Matthias Kirchner and Jessica Fridrich	2010	In digital image forensics, this technique is effective in detecting malicious post processing.	This approach is also applicable to steg analysis and watermarking.	Detectors were found to be ineffective for JPEG-compressed images after filtering.
AgrawalRicha	2014	By combining Histogram Thresholding with FCM, region expanding, and K-mean and Watershed segmentation, an MRI will automatically detect a brain tumour.	The ability of this algorithm to reliably detect and classify the contour of the tumour was demonstrated by simulation results.	The calculation time and accuracy were substantially lower than those of the other algorithms.

Tiwari R.B.	2011	The Laplacian-of-a-Gaussian (LoG) Filter is suggested as an adaptive technique for improving the contrast quality of dental X-ray images.	It is a segmentation approach that provides precision, complexity, performance, and interactivity.	The process is diffracted by some of the current edges in the noisy picture in the LoG filter.
Joshi SnehalK	2014	To compare a digital image processing algorithm projected with an X-ray CT image to evaluate the compositions of the concrete mixture.	Threshold algorithms are a major improvement over the manual and subjective methods of analysis previously employed.	Median filtering does not fully eliminate noise, but it does significantly minimise it.
DevisTuia and Gustavo Camps-Valls	2020	This paper offers a survey of methods and applications in remote sensing image processing, highlighting hot topics and recent methodological advances.	This includes urban surveillance and fire detection, as well as economic and environmental implications.	If there is a need to evaluate various aspects of photography functionality, it is costly to analyze repetitive photographs.
PO-Whei Huang et al	2012	For bitewing dental X-ray pictures, this paper presents a highly successful and completely automated tooth isolation process.	As compared to Nomir and Abdelmethod, Mottaleb's method achieves higher tooth isolation accuracy rates for both upper and lower jaw pictures.	The bitewing X-ray can't always tell the difference between healthy surfaces, those with early caries, and cavitated lesions.
Reddy M.V.Brahmananda et al.	2012	To explain how image processing methods can be used to verify the x-ray and determine the degree of the caries lesion.	The algorithm is useful for segmenting caries from periapical dental x-ray images, which helps dentists with clinical care.	Dentists are yet to perform a severity-based classification of dental caries.

3. Proposed System

3.1 Material And Methods

3.1.1 Patients

This retrospective study was approved by Huazhong University of Science and Technology ethics committee, patient consent was waived due to the retrospective nature of this study. Between Dec. 13, 2019 to Feb. 6, 2020, we searched unenhanced chest CT scans of patients with suspected COVID-19 from the picture archiving and communication system (PACS) of radiology department (Union Hospital, Tongji Medical College, Huazhong University of Science and Technology). Finally, 540 patients (mean age, 42.5±16.1 years; range, 3-81 years, male 226, female 314) were enrolled into this study, including 313 patients (mean age, 50.7±14.7 years; range, 8-81 years; male 138, female 175) with clinical diagnosed COVID-19 (COVID-positive group) and 229 patients (mean age, 31.2±10.0 years; range, 3-69 years; male 88, female 141) without COVID-19 (COVID-negative group). There was no significant difference in sex between the two groups ($\chi^2=1.744$; $P=0.187$), age in COVID-positive group significantly higher than

that of COVID-negative group ($t=17.09$; $P<0.001$). The main clinical symptoms for these patients were fever, cough, fatigue, and diarrhea. Of all the patients, two were included by both groups due to the first and second follow-up CT scans. The first case (female, year 66) was diagnosed as COVID-19 negative on Jan 24, 2020, then changed into COVID-positive on Feb 6, 2020; the second case (female, year 23) was diagnosed as COVID-19 positive on Jan 24, 2020, then changed into COVID-negative on Feb 3, 2020. All the CT volumes scanned on and before Jan 23, 2020, were assigned for deep learning training, and all the CT volumes scanned after Jan 23, 2020, were assigned for deep learning testing.

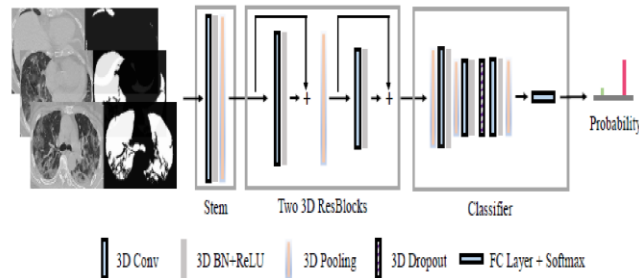


Figure 3. Architecture of the proposed DeCoVNet.

The network took a CT volume with its 3D lung mask as input and directly output the probabilities of COVID-positive and COVID-negative.

3.1.2. Image Acquisition

The CT scanning of all the enrolled patients was performed on a gemstone CT scanner (GE Discovery CT750HD; GE Healthcare, Milwaukee, WI), and were positioned in a headfirst supine position, with their bilateral arms raised and placed beside bilateral ears. All the patients underwent CT scans during the end-inspiration without the administration of contrast material. Related parameters for chest CT scanning were listed as follows: field of view (FOV), 36 cm; tube voltage, 100 kV; tube current, 350 mA; noise index, 13; helical mode; section thickness, 5 mm; slice interval, 5 mm; pitch, 1.375; collimation 64×0.625 mm; gantry rotation speed, 0.7 s; matrix, 512×512 ; the reconstruction slice thickness 1 mm with an interval of 0.8 mm; scan range from apex to lung base; the mediastinal window: window width of 200 HU with a window level of 35 HU, and the lung window: window width of 1500 HU with a window level of -700 HU.

3.1.3. Ground-truth Label

In the diagnosis and treatment protocols of pneumonia caused by a novel coronavirus (trial version 5) which was released by National Health Commission of the People's Republic of China on Feb 4, 2020, suspected cases with characteristic radiological manifestations of COVID-19 has been regarded as the standard for clinical diagnostic cases in severely affected areas only in Hubei Province, indicating that chest CT is fundamental for COVID-19 identification of clinically diagnosed cases. Typical CT findings for COVID-19 are also listed: multifocal small patchy shadowing and interstitial abnormalities in the early stage, especially for the peripheral area of the bilateral lungs. In the progressive period, the lesions could increase in range and in number; it could develop into multiple GGO with further infiltration into the bilateral lungs. In severe cases, pulmonary diffuse consolidation may occur and pleural effusion is rarely shown. The combination of epidemiologic features (travel or contact history), clinical signs and symptoms, chest CT, laboratory findings and real-time RT-PCR for SARS-CoV-2 nucleic acid testing is used for the final identification of COVID-19. The medical CT reports were acquired via the electronic medical record of Union Hospital, Tongji Medical College, Huazhong University of Science and Technology. According to the CT reports, if a CT scan was COVID-positive, its ground-truth label was 1; otherwise, the label was 0. The dataset does not contain other pneumonia and all negative cases are healthy patients. To evaluate the performance of our algorithm for COVID-19 lesion localization, the bounding boxes of COVID-19 lesions in testing CT scans were manually annotated by a professional radiologist with 15 years of experience working in chest CT.

3.1.4 The Proposed DeCoVNet

We proposed a 3D deep convolutional neural Network to Detect COVID-19 (DeCoVNet) from CT volumes. As shown in Fig. 1, DeCoVNet took a CT volume and its 3D lung mask as input. The 3D lung mask was generated by a pre trained UNet.. DeCoVNet was divided into three stages for a clear illustration in Table. I. The first stage was the network stem, which consisted of a vanilla 3D convolution with a kernel size of $5 \times 7 \times 7$, a batchnorm layer and a pooling layer. The setting of the kernel size of $5 \times 7 \times 7$ follows, which is helpful to preserve rich local visual information. The second stage was composed of two 3D residual blocks (ResBlocks). In each ResBlock, a 3D feature map was passed into both a 3D convolution with a batchnorm layer and a shortcut connection containing a 3D convolution that was omitted for dimension alignment. The resulting feature maps were added in an element-wise manner. The third stage was a progressive classifier (ProClf), which contained three 3D convolution layers and a fully-connected (FC) layer with the softmax activation function. ProClf progressively abstracts the information in the CT volumes by 3D max-pooling and finally directly outputs the probabilities of being COVID-positive and COVID-negative. The 3D lung mask of an input chest CT volume helped to reduce background information and better classify COVID19. Detecting the 3D lung mask was a well-studied issue. In this study, we trained a simple 2D UNet using the CT images in our training set. To obtain the ground-truth lung masks, we segmented the lung regions using an unsupervised learning method, removed the failure cases manually, and the rest segmentation results were taken as ground truth masks. The 3D lung mask of each CT volume was obtained by testing the trained 2D UNet frame-by-frame without using any temporal information. The overall training and testing procedures of UNet and DeCoVNet for COVID-19 classification as shown in figure below.

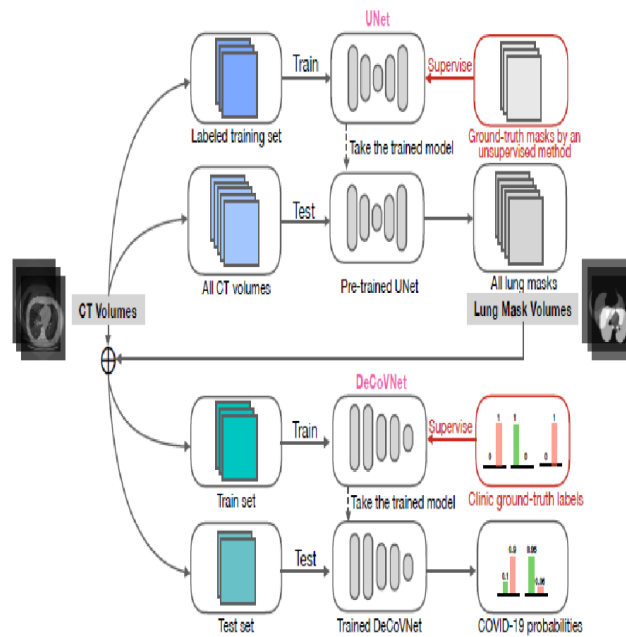


Fig. 4 Training and testing procedures

3.1.5. Weakly-supervised Lesion Localization

Our idea of weakly-supervised COVID-19 lesion localization was to combine the activation regions produced by the deep classification network (i.e., DeCoVNet) and the unsupervised lung segmentation method. The method is illustrated in Fig. 3. In the right part, we inferred a few candidate lesion regions from DeCoVNet by applying the class activation mapping (CAM) method proposed in. The DeCoVNet activation regions had a good recall, but they made many false positive predictions. In the left part of Fig. 3, we extracted potential COVID19 lesion regions from the unsupervised lung segmentation results. After applying the 3d connected component (3DCC) method to the CT scan, we found the lesion regions were sensitive to the 3DCC algorithm, which could be utilized for lesion localization. To get the response map, we calculated the variance (including the standard deviation and the number of connected components) in a 7×7 window for each pixel as the 3DCC activation. Then, the 3DCC activation region with the largest size was selected and termed as R3dcc. Lastly, the CAM activation region that had the largest overlap with R3dcc was selected as the final COVID-19 lesion localization result.

3.1.6. Data Preprocessing and Data Augmentation Preprocessing of 2D UNet:

All the CT volumes were preprocessed in a unified manner before training the 2D UNet for lung segmentation. First, the unit of measurement was converted to the Hounsfield Unit (HU) and the value was linearly normalized from 16-bit to 8-bit (i.e., 0-255) after determining the threshold of HU window (e.g., -1 200-600 HU). After that, all the CT volumes were resampled into the same spatial resolution (e.g., 368×368), by which the CT volumes could be aligned without the influence of the cylindrical scanning bounds of CT scanners. This step was applied to the obtained ground-truth lung masks as well.

Preprocessing of DeCoVNet: For each CT volume, the lung masks produced by the trained UNet formed a mask volume, then the CT volume was concatenated with the mask volume to obtain a CT-Mask volume. Finally, the CT-Mask volume was resampled into a fixed spatial resolution (e.g., 224×336) without changing the number of slices for DeCoVNet training and testing. The number of slices in the whole dataset was 141 ± 16 ranging from 73 to 250. Data Augmentation: To avoid the overfitting problem since the number of training CT volumes was limited, online data augmentation strategies were applied including random affine transformation and color jittering. The affine transformation was composed of rotation ($0^\circ \pm 10^\circ$), horizontal and vertical translations ($0\% \pm 10\%$), scaling ($0\% \pm 20\%$) and shearing in the width dimension ($0^\circ \pm 10^\circ$). The color jittering adjusted brightness ($0\% \pm 50\%$) and contrast ($0\% \pm 30\%$). For each training sample, the parameters were randomly generated and the augmentation was identically applied for each slice in the sampled CT volume.

3.1.7 Training and Testing Procedures

The DeCoVNet software was developed based on the PyTorch framework [29]. Our proposed DeCoVNet was trained in an end-to-end manner, which meant that the CT volumes were provided as input and only the final output was supervised without any manual intervention. The network was trained for 100 epochs using Adam optimizer [30] with a constant learning rate of $1e-5$. Because the length of CT volume of each patient was not fixed, the batch size was set to 1. The binary cross entropy loss function was used to calculate the loss between predictions and ground-truth labels. During the procedure of testing, data augmentation strategies were not applied. The trained DeCoVNet took the preprocessed CT-Mask volume of each patient and output the COVE positive probability as well as COVID-negative probability. Then the predicted probabilities of all patients and their corresponding ground-truth labels were collected for statistical analysis. The cohort for studying the COVID-19 classification and weakly-supervised COVID-19 lesion detection contained 630 CT scans collected from Dec 13, 2019 to Feb 6, 2020. To simulate the process of applying the proposed DeCoVNet for clinical computer-aided diagnosis (i.e., prospective clinical trials), we used the 499 CT scans collected from Dec 13, 2019 to Jan 23, 2020 for training and used the rest 131 CT volumes collected from Jan 24, 2020 to Feb. 06, 2020 for testing. Of the training volumes, 15% were randomly selected for hyperparameter tuning during the training stage.

3.1.8. Statistical Analysis

COVID-19 classification results were reported and analyzed using receiver operating characteristic (ROC) and precision recall (PR) curves. The area under the ROC curve (ROC AUC) and the area under the precision-recall curve (PR AUC) were some key operating points used to assess the deep learning algorithm. To quantitatively analyse the performance of our weakly supervised lesion localization algorithm, we followed the evaluation metric in [31] to calculate the lesion hit rate as follows. For each of the CT scans predicted as positive by DeCoVNet, we took the most confident 3D lesion mask predicted by the proposed weakly-supervised lesion localization algorithm; if the center of predicted 3D lesion mask was inside any one of the annotated boxes, it was a successful hit; otherwise, it failed to hit; finally, we calculated the hit rate by dividing the number of successful hits over all the number of true positives.

4. Implementation

The pandemic of coronavirus disease (COVID-19) is spreading all over the world. Thus detection of COVID disease has to be done. To reduce the spreading of disease, we can detect the disease through CT scan. Even through this technique there is a higher possibility of lab technicians to be infected since the detections are done manually. To overcome this, a deep learning algorithm combined with analysis of segmented CT scan image, we can provide an

automated COVID test result stating COVID positive or COVID negative without any physical contact with the patients. Thus we can further prevent the spreading of COVID disease.

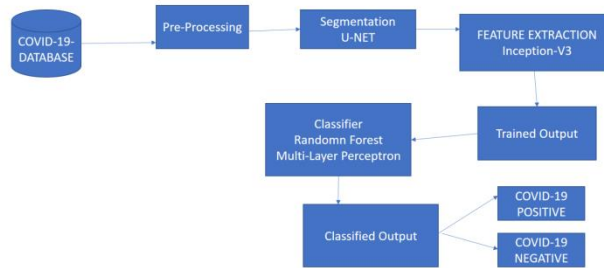


Figure 5 Architecture of the System

4.1 Dataset Collections

The datasets were collected for the input which is trained using tensorflow software where the image is classified into two classes negative and positive classes for an input image the input image is chosen from that in graphical user interface model .



Figure 6.input data

4.2 Segmentation

After the Image was chosen it is done the segmentation process where in the segmentation process the image is masked and then masked place where masked drawn, then the image was mask segmented done. the segmentation done using a UNET in CNN segmentation process .the segmentation is done.

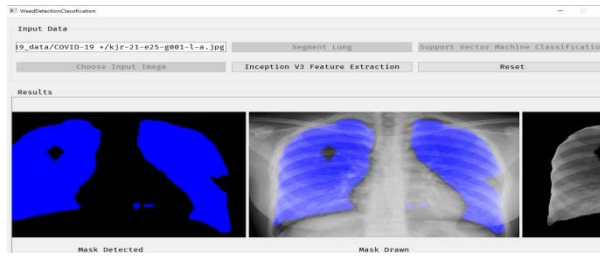


Fig.7 mask detected and drawn

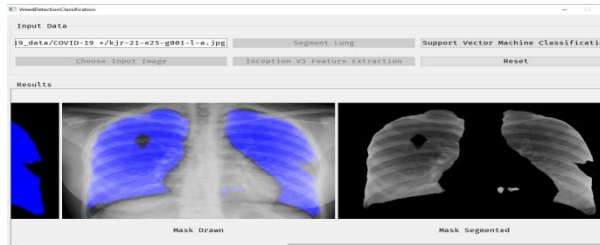


Fig.8 mask segmented

4.3 Feature Extraction and Classification

The completion of the segmentation process the feature extraction is take place where the feature is extracted from the segmented image for further process where the feature extraction where done using the Inception V3 algorithm .then completion of extracting the feature the classification of an image for output was take place the classification was done using the Random Forest Classifier algorithm .after the process of classification the output is displayed either positive or negative in COVID-19



Fig 9 extraction and classified output

5.Conclusion

In the battle against COVID-19, intelligent medical imaging has been crucial. We show how AI can provide secure, reliable, and efficient imaging solutions in COVID-19 applications in this project. COVID-19 encompasses the entire pipeline of AI-empowered imaging technologies, including intelligent imaging systems, clinical diagnosis, and visionary science. To demonstrate the efficiency of AI-empowered medical imaging for COVID-19, two imaging modalities, namely X-ray and CT, are used. It's worth noting that imaging only gives you a partial image of COVID-19 patients. As a result, in this project, we will integrate imaging data with clinical manifestations and laboratory test findings in order to improve COVID-19 screening, identification, and diagnosis.

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