# Covid Detection using deep learning and CNN

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*Abstract :* Until now millions of people have contracted covid and many have died because of covid. These have spread all over the world and caused the medical infrastructure a lot of damage and presented numerous challenges in front of them.The key component for research in covid is the availability of a dataset. With limited availability of chest ultrasound images and time constraints with the disease fast and accurate results are very important. There has been a lot of development using deep learning in detecting chest related diseases. The Robustness' and generalization of covid detection using these images is questionable though. We aimed to use thousands of readily available chest ultrasound images with clinical findings associated with COVID-19 as a training data set, mutually exclusive from the images with confirmed COVID-19 cases, which will be used as the testing data set. In particular, we present a novel deep learning approach which detects the affected area and its severity.

***Keywords* - Deep neural network,deep learning, COVID-19.**

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## I. INTRODUCTION

The rapid growth in SARS Covid-19 had resulted in scarcity of medical infrastructure and facilities governments and medical staff have faced lots of challenges during this pandemic. As the cases increase daily there is the challenge to detect the spread of Covid in the body is challenging as the Xray image don't give accurate outputs.

The COVID-19 pneumonia can rapidly progress and cause serious damages to the patient Examination of radiological images of over 1,000 COVID-19 patients showed many acute respiratory distress syndrome (ARDS)-like characteristics, such as bilateral, and multilobar glass ground opacifications (mainly posteriorly and/or peripherally distributed]. As such, chest computed tomography has been coined as a potential alternative for diagnosing COVID-19 patients. While RTPCR may take up to 24 hours and requires multiple tests for definitive results, diagnosis using CT can be much quicker. However, use of chest CT comes with significant drawbacks: it is costly, exposes patients to radiation, requires extensive cleaning after scans, and relies on radiologist interpretability. Ultrasound images are more widely popular these days and they are also cost effective, real time imaging and safe. In some cases it shows greater sensitivity and accuracy than X-ray in detecting Pneumonia. The LUS images have been used in COVID detection. The broad range of applicability and relatively low costs make ultrasound imaging an extremely useful technique in situations when patient inflow exceeds the regular hospital imaging infrastructure capabilities. Thanks to its low costs, it is also accessible for low- and middle-income countries.

This paper advances the state of the art in the automatic analysis of LUS images for supporting medical personnel in the diagnosis of COVID-19 related pathologies in many directions. We propose an extended and fully-annotated version of the ICLUS-DB database. The dataset contains labels on the 4-level scale proposed in , both at frame and video-level. Furthermore, it includes a subset of pixel-level annotated LUS images useful for developing and accessing semantic segmentation methods. We introduce a novel deep architecture which permits to predict the score associated to a single LUS image, as well as to identify regions containing pathological artifacts in a weakly supervised manner. Our network leverages Spatial Transformers Network (STN) and consistency losses to achieve disease pattern localization and from a soft ordinal regression loss for robust score estimation. We introduce a simple and lightweight approach based on uninorms to aggregate frame-level predictions and estimate the score associated to a video sequence.

## II. RELATED WORK

DL has proven to be successful in a multitude of computer vision tasks ranging from object recognition and detection to semantic segmentation. Motivated by these successes, more recently, DL has been increasingly used in medical applications, e.g. for biomedical image segmentation or pneumonia detection from chest X-ray . These seminal works indicate that, with the availability of data, DL can lead to the assistance and automation of preliminary diagnoses which are of tremendous significance in the medical community. In the wake of the current pandemic, recent works have focused on the detection of COVID-19 from chest CT. In a U-Net type network is used to regress a bounding box for each suspicious COVID-19 pneumonia region on consecutive CT scans, and a quadrant-based filtering is exploited to reduce possible false positive detections. Differently, in a threshold-based region proposal is first used to retrieve the region of interest (RoIs) in the input scan and the Inception network is exploited to classify each proposed RoI. Similarly, a VNET-IR-RPN model pre-trained for pulmonary tuberculosis detection is used to propose RoIs in the input CT and a 3D version of Resnet-18 is employed to classify each RoI. However, very few works using DL on LUS images can be found in the literature. A classification and weakly supervised localization method for lung pathology is described in. Based on the same idea, in a frame-based classification and weakly-supervised segmentation method is applied on LUS images for COVID-19 related pattern detection. Here, Efficient net is trained to recognize COVID-19 in LUS images, after which class activation maps (CAMs) are exploited to produce a weakly-supervised segmentation map of the input image. Our work has several differences compared to all the previous works. First, while in CAMs are used for localization, in this work we exploit STN to learn a weakly-supervised localization policy from the data (i.e. not exploiting explicit labelled locations but inferring it from simple frame-based classification labels). Second, while a classification problem is solved, we focus on ordinal regression, predicting not only the presence of COVID-19 related artifacts, but also a score connected to the disease severity. Third, we move a step forward compared to all previous methods by proposing a video-level prediction model built on top of the frame-based method. Finally, we propose a simple yet effective method to predict segmentation masks using an ensemble of multiple state-of-the-art convolutional network architectures for image segmentation. Additionally, the model's predictions are accompanied with uncertainty estimates to facilitate interpretation of the results.

## III. METHODS

### A. Imaging

Biomedical imaging has the potential to complement conventional diagnostic procedures for COVID (such as RT-PCR or immune assays). It can provide a quick assessment and guide downstream diagnostic tests, especially in triage situations or low-resource settings. Although RT-PCR has a sensitivity that is not higher than 80% for any moment in time after infection, it is the sole recommendation for COVID-19 diagnosis according to the ACR. Several studies reported that CT imaging can detect COVID-19 at higher sensitivity rate compared to RT-PCR (98% vs 71%, Fang et. al., 2020 and 88% vs. 59% Ai et. al., 2020). In any case: Even if the sensitivity of PCR would be 100%, we have to recognize that both PCR and CT are not available to the majority of the world's population. This calls into play surrogate imaging modalities (chest X-Ray and lung ultrasound) to rapidly screen and stratify COVID-19 suspects.

### B. Ultrasound Imaging

Ultrasound data was shown to be highly correlated with CT, the gold standard for lung diseases. Instead of CT, ultrasound is non-invasive, cheap, portable (bedside execution), repeatable and available in most medical facilities. But even for trained doctors detecting COVID-19 from ultrasound data is challenging and time-consuming. Since their time is scarce, there is an urgent need to simplify, fasten & automatize the detection of COVID-19. This project is a proof of concept, showing that a CNN is able to learn to distinguish between COVID-19, Pneumonia and healthy patients with an accuracy of 89% and sensitivity for COVID of 96%. This is by no means clinically relevant and tons of further work must be done, e.g. on differentiating COVID from other viral pneumonias.

### C. Point of care Ultrasound

a. Cheap: While one X-ray examination is estimated to cost around $370, and CT starting from $500 to $3000, ultrasound (US) may be a bargain with only approximately $140. Also, the device itself is reasonable and thus easy to distribute, ranging from $2000 for portable devices.
b. Easy to use: most doctors skills to perform an ultrasound. There are not any safety measures like radiation, and therefore the devices are handy.
c. Fast: With one device, it's possible to perform 4 to five lung screenings per hour
d. Portable: "point-of-care" says it all. The patients do not have to be moved, which saves lots of time and effort.
e. Safe: With US, you do not use any irradiating element. Period. Any X-Ray or CT examination slightly increases the lifetime risk of cancer, especially for younger patients.

Despite these advantages, ultrasound has only been integrated into the diagnostic process of lung diseases in the past few years. Certain characteristic pathological patterns, like so-called B-lines, A-lines and barcode signs, are often analyzed to diagnose for instance pleural effusion, alveolar consolidation, interstitial syndrome and pneumothorax. As COVID-19 alters the lung ultrasound patterns in similar ways, the applicability of ultrasound for COVID-19 was now studied in several publications and its sensitivity was compared to CT. The results are very clear: In accordance with, the authors of (published within the prestigious journal The Lancet Respiratory Medicine) advocate for a more prominent role folks for COVID-19 diagnosis, and supply evidence that the sensitivity to detect COVID-19 from US is extremely almost like the one among CT. A noteworthy drawback is that doctors have to be trained to recognize COVID and observing COVID-specific patterns is not an easy task but requires some experience. In the current situation, the time for extensive training is limited though.

We believe that an answer is given by an assistance system for doctors that automatically classifies ultrasound recordings with computer vision techniques. Such a system could support doctors in their decisions, and provides a primary assessment of the probability that the patient is infected.
LUS is a safe, readily available tool that can be employed by EPs to provide real-time clinical assessment for COVID-19. Lab testing utility is hampered by delays in results, accuracy, and availability. CXR may miss pulmonary disease, and the ACR has cautioned against routine screening with chest computed tomography (CT), citing concerns of poor specificity of ground-glass opacities for COVID-19 as well as infection control procedures necessary to decontaminate the CT scanner. Regarding infection control procedures, we expect that portable (or hand-held) ultrasounds would be easier to decontaminate than portable CXR machines or CT suites.
This paper tackles several challenges towards the event of automatic approaches for supporting medical personnel within the diagnosis of COVID-19 related pathologies . In particular, following the COVID-19 LUS scoring system we present a novel deep architecture which automatically predicts the pathological scores associated to all frames of a LUS image sequence and optimally fuse them to supply a disease severity score at video-level. We also show that the proposed model automatically identifies regions in an image which are associated with pathological artifacts without requiring pixel level annotation. Finally, to further improve the accuracy in the automatic detection of disease-related patterns, we also consider a scenario where frames are provided with

pixel-level annotations and we propose a segmentation model derived from a state of the art convolutional network architecture .In the following, we describe the proposed deep learning models

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With the aim of supporting medical personnel within the analysis of LUS images,

In this paper we introduce an approach for predicting the presence or the absence of a pathological artifact in each frame of a LUS image sequence and for automatically assessing the severity score of the disease associated with such patterns consistent with the COVID-19 LUS rating system . We are also interested in the spatial localization of a pathological artifact in the frame without assuming any annotation about such artifact positions in a frame. The weak localization is achieved through the utilization of Spatial Transformer Networks(STN). The use of STN stems from the fact that most of the pathological artifacts are concentrated in a relatively small area of the image, and, hence the entire image should not be considered by the network to make predictions.

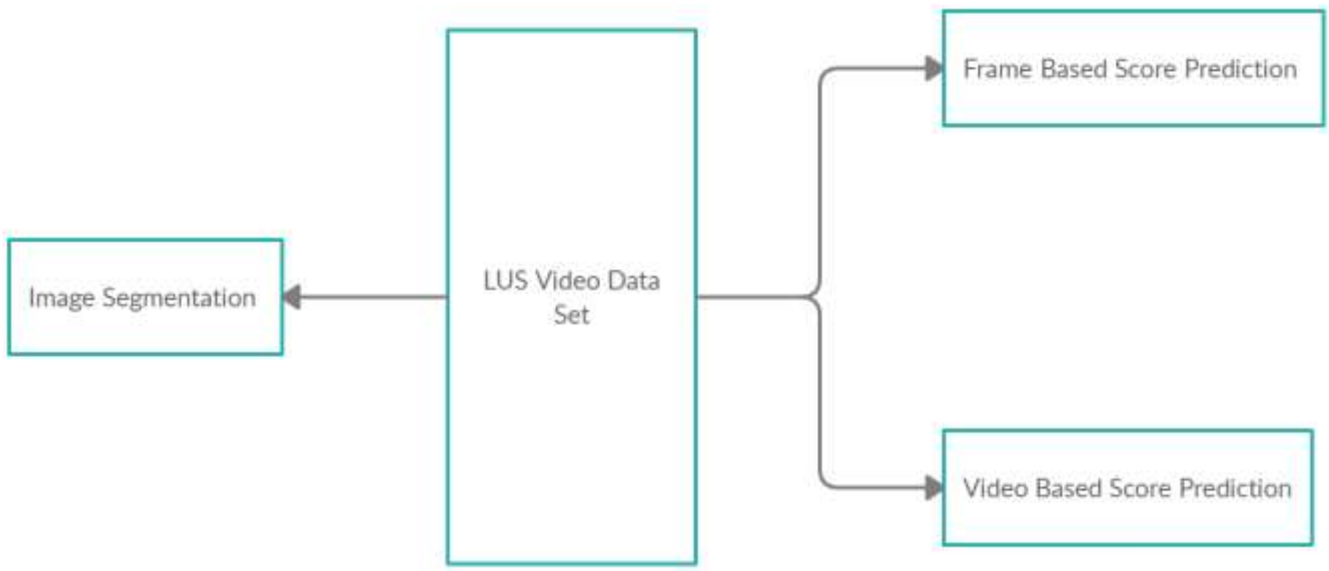


Figure 1: System Architecture

## IV. CONCLUSION

A benefit of using ultrasound is the low risk of cross infection when using a plastic disposable cover and individually packaged ultrasound gel on a portable handheld machine . This is in contrast with use of CT, for which rooms and systems need to be rigorously cleaned to prevent contamination (and preferably reserved for patients with a high COVID-19 suspicion). LUS can be performed inside the patient's room without need of transportation, making it a superior method for point-of-care assessment of patients. Moreover, ultrasound renders real-time images and, combined with our DL methods, provides results instantly. It may also directly assist in triage of patients; first-look estimation of the disease's severity and the urgency at which a patient needs to be addressed. In addition, low and middle-income countries, where diagnosis through RT-PCR or CT may not always be available, can particularly benefit from low-cost ultrasound imaging as well. However lack of training on the interpretation of these LUS images could still limit its use in practice. Our proposed DL method may therefore facilitate ultrasound imaging in these countries.

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