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EDITORIAL

Advanced Deep Learning Techniques for COVID-19

ABSTRACT

One of the serious issues that concern the world during this time is the Coronavirus outbreak (COVID-19). COVID-19 symptoms may be similar to other viral chest diseases in some of the symptoms that may cause the doctor's uncertainty in making the correct diagnosis decision due to the novelty of this virus. The fast transmission of the COVID-19 virus and its impact on the global economy led research to investigate novel solutions based on state-of-the-art deep learning approaches for rapid diagnosis of the disease. This special issue focuses on novel deep learning imaging analysis techniques related to COVID-19. Only seven papers were chosen through a very competitive selection process and rigorous review process since the authors demonstrated numerous research themes on Advanced Deep Learning Techniques for COVID-19. The papers in this special issue present visions in advanced deep learning techniques for COVID-19 and deep learning approaches to medical image analysis to diagnose COVID-19 patients. The rapid diagnosis and isolation of COVID-19 patients are essential to control the spread and its global impact on world health, social and digital economy.

Keywords: COVID-19 detection, COVID-19 analyses, AI and Data Science for COVID-19, COVID-19 recommendations.

1. INTRODUCTION

The most serious issue that concerns the world during this period is the novel Coronavirus outbreak (COVID-19). The quick distribution of the virus around the world puts a real threat to all countries. Thus, researchers must pay attention to studying the details of this calamity. COVID-19 symptoms may be similar to other viral chest diseases in some of the symptoms that may cause the doctor's uncertainty in making the correct diagnosis decision due to the novelty of this virus. The recent diagnosis of COVID-19 is based on real-time reverse-transcriptase polymerase chain reaction (RT-PCR) and is regarded as the gold standard for confirmation of infection. It has already been widely recognized that deep learning techniques can potentially have a substantial role in streamlining and accelerating the diagnosis of COVID-19 patients. Numerous open dataset enterprises have been set up over the past weeks to help the researchers develop and check methods that could contribute to countering the Corona pandemic. In order to report the above unique problems in the diagnosis of COVID-19, pioneering techniques should be developed. This special issue focuses on novel deep learning imaging analysis techniques related to COVID-19 [1].

This special section provides a perfect platform to submit manuscripts that discuss the prospective developments and innovative ideas in deep learning techniques in the diagnosis of COVID-19. We received 64 submissions. Only

seven papers were chosen through a very competitive selection process and rigorous review process since the authors demonstrated numerous research themes on Advanced Deep Learning Techniques for COVID-19**.**

The fast transmission of the COVID-19 virus and its impact on the global economy led research to investigate novel solutions based on state-of-the-art deep learning approaches for rapid diagnosis of the disease. Deep learning approaches are developed based on the understanding of the brain, its structure, and functionality applied to a variety of application areas [2].

2. THEMES OF THIS SPECIAL ISSUE

This special issue includes seven original papers based on the review outcomes from independent reviewers. The selected papers are brief as follows:

The first paper, entitled 'RLDD: an advanced residual learning diagnosis detection system for COVID-19 in IIOT' authored by Dong et al., investigates the use of Computed Tomography (CT) images to diagnose lung infection. The authors have applied an advanced residual learning diagnosis detection technique to identify positive COVID-19 cases more effectively. The proposed approach is applied to a public dataset that has achieved an accuracy of 91.33%, a precision of 91.30%, and a recall of 90% on a sample of 150 batches. Before applying the data set approach, pre-processing in RGB was applied to uniform the image resolution (224x224). The data set was labeled. The kernel size was set to 3X3. The convolution layer learns the important features relevant to the diagnosis of COVID-19. The authors applied Adam optimizer with the initial learning rate of 0.001, decay co-efficient at a rate of 0.5, and the number of epochs was 1500.

The second paper, entitled 'CovTANet: a hybrid tri-level attention based network for lesion segmentation, diagnosis, and severity prediction of COVID-19 chest CT scans' authored by Fattah et al., proposes a hybrid approach for COVID-19 diagnosis. This research has applied a neural network-based approach to CT images for COVID-19 diagnosis, lesion segmentation, and prediction of disease level. The proposed approach is applied to a public data set containing 1110 samples and achieved high performance. The proposed tri-level attention unit approach is comprised of three steps: channel-level, spatial level, and pixel-level. As reported in the paper, the channel attention mechanism focuses on the high view of channels comprising more information. The spatial attention mechanism focuses on the local spatial regions' interests. The pixel attention mechanism focuses on the lower level view relating to the analysis of each pixel. The authors applied Adam optimizer with an initial learning rate of 10^{-5} decay co-efficient at a rate of 0.99 after every 10 epochs.

The third paper, entitled 'EDL-COVID: ensemble deep learning for COVID-19 cases detection from chest X-Ray images' authored by Tang et al., proposes ensemble deep learning. The proposed approach is applied to a dataset containing 15477 CXR images, comprising 6053 Pneumonia, 8, 851 Normal, and 573 COVID-19 cases images. The proposed EDL-COVID approach can perform a prediction with multiple models based on deep learning and ensemble learning

comprising a weighted average ensembling strategy. The proposed approach is applied to chest x-ray images to diagnose COVID-19 patients. The approach has achieved COVID-19 detection accuracy of 95%.

The fourth paper, entitled 'Intelligent Intraoperative Haptic-AR navigation for COVID-19 Lung Biopsy using Deep Hybrid Model' authored by Tai et al., describes the systems developed and the algorithms used to develop the biopsy surgical navigator. A novel deep learning technique was developed to help thoracic surgeons perform an image-guided lung biopsy of patients with COVID-19. In the new system, a WPD-CNN based LSTM model is developed to estimate the lung biopsy accuracy and the Deep Residual Network (ResNet) is employed for the viscera classification during the biopsy. The approach was evaluated with Twenty-four thoracic surgeons, and the experiments showed that its novel approach outperformed existing approaches, which in turn opens new lines of enquiry for deep learning in surgical navigation.

The fifth paper, entitled 'Augmented Multi-center Graph Convolutional Network for COVID-19 Diagnosis' authored by Lei et al., develops a Graph Convolutional Network (GCN) to take into account the different centers. In the assessment of COVID-19 patients, a chest Computed Tomography (CT) scan is taken to relieve the burden on radiologists and physicians, and an automatic assessment can be used to support the diagnosis. Any automatic assessment would need to handle images from different equipment (and set up conditions) from different centers. The algorithm is named '*augmented multi-center graph convolutional network* (AM-GCN)'. An evaluation of the new approach was conducted using a CT scan from seven different data centers, achieving a mean accuracy of 97.76%. This approach could now be applied to other classification tasks where data come s from different centers with different setup conditions.

The sixth paper, entitled 'An Effective Deep Neural Network for Lung Lesions Segmentation from COVID-19 CT Images' authored by Xiao et al., proposes a new process for segmentation CT images, described how to support this diagnostic process. Radiologists rely on their experience when looking at using a CT of the lungs to diagnose suspect features (single or multiple ground glass-like lesions, solid lesions, and thickened leaflet intervals) in patients with COVID-19. The process used Region of Interest (ROI) to identify possible infected areas of the lung. Then using deep learning to extract features and finally, a Conditional Random Field (CRF) is used to classify the features. The evaluation demonstrated that this approach outperformed other commonly used approaches. The work could be used to support the diagnoses of CT scans in other physiological parts of the body, such as liver lesions.

The last paper, entitled 'COVID-19: Automatic Detection of the Novel Coronavirus Disease from CT Images Using an Optimized Convolutional Neural Network' authored by Castiglione et al., proposes a novel classification model that analyzes chest CT images for the early prediction of the COVID-19 disease. Authors use chest CT images from a public COVID-19 dataset that are properly pre-processed

and normalized. After that, they split the dataset of CT-images into two different parts: a test set and a training one. Specifically, the training set is then used to classify COVID-19 infected patients and create a reference model. The proposed method was compared to the existing reference transfer learning models (such as the ResNet, GoogleNet, and VGG19). The extensive experiments carried out by the authors proved that their method outperforms the other models in specificity (99.97%), accuracy (99.99%), precision (99.92%), and sensitivity (99.96%). Their approach also seems to be better than any other existing COVID-19 disease prediction method and can be easily implemented in real-time disease classification from chest CT images.

3. CONCLUSION

The papers shown in this special issue present visions in advanced deep learning techniques for COVID-19 and deep learning approaches to medical image analysis to diagnose COVID-19 patients. The rapid diagnosis and isolation of COVID-19 patients are essential to control the spread and its global impact on world health, social and digital economy. We hope the readers can benefit from the insights of these papers and contribute to these rapidly growing areas.

4. ACKNOWLEDGEMENT

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APPENDIX

RELATED WORK

[1] M. Abdel-Basset, V. Chang, & R. Mohamed, (2020). “HSMA_WOA: A hybrid novel Slime mould algorithm with whale optimization algorithm for tackling the image segmentation problem of chest X-ray images”. Applied Soft Computing, 95, 106642.

[2] R. Iqbal, T., Maniak, T., F. Doctor & C. Karyotis, (2019). “Fault detection and isolation in industrial processes using deep learning approaches”, IEEE Transaction on Industrial Informatics, Volume 15, Issue 5, pp 3077-2084.

5. Guest Editors

Prof. Victor Chang is a Full Professor of Data Science and Information Systems, School of Computing and Digital Technologies, Teesside University, Middlesbrough, UK, since September 2019. He leads Artificial Intelligence and Information Systems Research Group at Teesside University. He was a Senior Associate Professor, Director of Ph.D. and MRes Programs at International Business School Suzhou (IBSS), Xi'an Jiaotong-Liverpool University (XJTLU), Suzhou, China. He joined XJTLU in June 2016. He is still a Visiting Researcher at the University of Southampton, UK. Previously he worked as a Senior Lecturer at Leeds Beckett University, UK, for 3.5 years. Within 4 years, he completed Ph.D. (CS, Southampton) and PGCert (Higher Education, Fellow, Greenwich) while working full time. Before becoming an academic, he has achieved 97% on average in 27 IT certifications. He won a European Award on Cloud Migration in 2011, IEEE Outstanding Service Award in 2015, best papers in 2012, 2015 and 2018, 2016 European award: Best Project in Research, 2016–2018 SEID Excellent Scholar, Suzhou, China, Outstanding Young Scientist 2017, 2017 special award on Data Science, 2017–2020 INSTICC Service Awards, Top 2% Scientists 2017, 2019 and all careers, most productive scientist in data analytics (2010–2019) and numerous awards since 2012. He is an Editor-in-Chief of IJOCI & OJBD journals, former Editor of FGCS, Editor of Information Fusion and Associate Editor of TII, and founding Conference Chair of IoTBDS http://www.iotbd.org, COMPLEXIS http://www.complexis.org, FEMIB http://femib.scitevents.org and IIoTBDSC http://iiotbdsc.com. He was involved in different projects worth more than £13 million in Europe and Asia. He has published 3 books as sole authors and the editor of 2 books on Cloud Computing and related technologies. He gave 23 keynotes at international conferences.

Dr. Mohamed Abdel-Basset received his B.*Sc*. and M.*Sc* from Faculty of Computers and Informatics, Zagazig University, Egypt. Received his Ph.D from Faculty of Computers and Informatics, Menoufia University, Egypt. Currently, Mohamed is Associate Professor at Faculty of Computers and Informatics, Zagazig University, Egypt. His current research interests are Optimization, Operations Research, Data Mining, Computational Intelligence, Applied Statistics, Decision support systems, Robust Optimization, Engineering Optimization, Multi-objective Optimization, Swarm Intelligence, Evolutionary Algorithms, and Artificial Neural Networks. He is working on the application of multi-objective and robust meta-heuristic optimization techniques. He is also an/a Editor/reviewer in different international journals and conferences. He holds the program chair in many conferences in the fields of decision making analysis, big data, optimization, complexity and internet of things, as well as editorial collaboration in some journals of high impact.

Dr. Rahat Iqbal is a Senior Academic, Director, Inventor and Consultant with 20 years' experience in industrial and academic roles. He is Leading the Connected Mobility Research Group in the Institute of Future Transport and Cities (IFTC) and Director at Interactive Coventry Ltd. His main research interests lie in Big Data Analytics, AI / Machine Learning and IoT. He is also working on emotions modelling, data driven security, computer vision systems, information retrieval and energy efficient communication protocols. The underlying data processing models used in his research are based on cutting edge biologically inspired artificial intelligence algorithms and human behaviour theories. Dr Iqbal has supervised to completion 17 PhD students and examined 15 doctorate theses. He has published more than 150 papers in international journals, conferences and books. He has edited several special issues of international journals and workshop proceedings. His work has resulted in high profile innovation awards, prestigious grants and 4 technology patents of high industrial uptake.

Dr. Gary Wills is an Associate Professor in Computer Science at the University of Southampton. He graduated from the University of Southampton with an Honours degree in Electromechanical Engineering, and then a PhD in Industrial Hypermedia Systems. He is a Chartered Engineer (CEng), a member of the Institute of Engineering Technology (MIET), a member of The International Association of Privacy Professionals (IAPP), and a Principal Fellow of the Higher Educational Academy (PFHEA). He is also a visiting professor at the University of Cape Town and a research professor at RLabs. Gary's research project focus on Secure Systems Engineering and applications for industry, medicine, and education. His research can be grouped under a number of themes: Internet of Things, Blockchain, Security, Data Protection, and Cloud Computing. Gary is qualified to undertake audits for Information Assurance (IASME and ISO27001), Cyber Essentials, GDPR readiness and Consumer IoT Security.