Since January 2020 Elsevier has created a COVID-19 resource centre with free information in English and Mandarin on the novel coronavirus COVID-19. The COVID-19 resource centre is hosted on Elsevier Connect, the company's public news and information website.

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Information Fusion 76 (2021) 175–176

Contents lists available at ScienceDirect

Information Fusion

journal homepage: www.elsevier.com/locate/inffus

Editorial

Editorial: Advances in multi-source information fusion for epidemic diseases

We are living in unprecedented times and as the coronavirus pandemic deepens and more restrictions are put in place around the world, the impact of the COVID-19 crisis on our lives can be troubling and confusing. With the continuous attempts of scientific research institutions, advanced information fusion technologies have been actively leveraged to comprehensively harness the multi-source epidemical information from medical devices, biomedical sensors, mobile terminals, social networks, etc., improving the efficiency for epidemic monitoring, virus tracking, prevention, control and treatment, and resource allocation.

Although the information fusion technologies have unique advantages and can play an important role in responding to epidemic diseases, there are three main challenges to develop strategies in practice: (i) gaps exist between researchers in different areas like computer science, bioinformatics, epidemiology and molecular modeling making it difficult to cognize the problem in depth from multi-source information; (ii) epidemiological information is vast so that we need considerable and effective approaches to harness it; (iii) there is still a lack of practical approaches, algorithms and tools for information fusion to fight the virus and save lives.

The response to our Call for Papers on this special issue was satisfactory, with 67 submissions from around the globe. During the review process, each paper was assigned to and reviewed by at least three experts in the relevant areas, with a rigorous at least two rounds review process. Thanks to the great support of the Editor-in-Chief of Information Fusion, Prof. FRANCISCO HERRERA TRIGUERO, we are able to accept 10 excellent articles with high quality that explore recent advances and disseminate state-of-the-art research on multi-source information fusion for epidemic monitoring, virus tracking, prevention, control and treatment, and resource allocation.

The first article, "The introduction of population migration to SEIAR for COVID-19 epidemic modeling with an efficient intervention strategy" [1], proposed a dynamics model of SEIR based on the epidemiological characteristics of COVID-19 in patients. After that, the proposed model was proved to be consistent with the transmission characteristics of COVID-19 through simulation experiments. Moreover, the simulation results emphasized the influence of social distancing and mobility rate on the total number of infections. This article provided a basis for the government to formulate policies to control the epidemic.

The second article titled "SDMP: A secure detector for epidemic disease file based on DNN" [2] proposed a secure detector of malicious PDF file for epidemic disease file based on Deep Neural Network to solve the problem of privacy and security in handling epidemic disease file. Experiment showed that the detection accuracy of the proposed detector could achieve up to 99.3%. Moreover, the time cost on training and forecasting of the proposed DNN model was extremely low, less than 1s per epoch.

In the next article with the title "COVID-19 classification by CCSHNet with deep fusion using transfer learning and discriminant correlation analysis" [3], the authors designed and developed a novel advanced AI system for COVID-19 classification based on chest CT (CCT) images. They first used a novel (L, 2) transfer feature learning algorithm to extract features with a hyperparameter of number of layers to be removed. Second, a selection algorithm of pretrained network for fusion was proposed to choose the best two models. Third, deep CCT fusion by discriminant correlation analysis was proposed to help fuse the two features from two models. From the test on the dataset, it proved that the new model named as CCSHNet was effective in detecting COVID-19 and other lung infectious diseases. It could assist radiologists to make the final diagnosis decisions.

The fourth article titled "Multi-source information fusion and deep-learning-based characteristics measurement for exploring the effects of peer engagement on stock price synchronicity" [4] applied a two-level information fusion approach to examine the effects of peer engagement on social media on stock price synchronicity, especially in epidemic contexts, based on multi-source information from financial market and social media. Multiple factors were constructed for characteristics measurement of peer engagement. Particularly, a more refined alternative measurement of informativeness was proposed through a deep-learning-based sentiment analysis. The empirical results showed that during epidemics, synchronicity was much higher, and group diversity and experts had stronger effects in lowering synchronicity, while the effects of informativeness and information diffusion were hampered.

In the fifth article, "COVID-19 and Non-COVID-19 Classification using Multi-layers Fusion From Lung Ultrasound Images" [5], a multi-layer fusion method of a CNN architecture was suggested for a COVID-19 screening framework based on lung ultrasound images. The proposed CNN was a lightweight model that had less than 0.4 million parameters. Features from different layers of the CNN were fused using a multilayer perceptron. The proposed method achieved a very high information density compared to other existing methods using pretrained CNN models.

In the next article with the title "Risk Prediction of Diabetes: Big data mining with fusion of multifarious physical examination indicators" [6], the authors designed a diabetes risk assessment system

https://doi.org/10.1016/j.inffus.2021.05.016
1 May 2021
Available online 5 June 2021
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to predict diabetes risk by fusing multifarious types of physical examination data. The system consisted of three modules: the diabetes risk assessment model, the diabetes risk scorecard, and the follow-up satisfaction model. It could evaluate diabetes risk from different levels. Thus, it was not only applicable to the public health system but was also convenient for the implantation of wearable devices or smart home systems based on the Internet of Things (IoT). This system was expected to provide guidance for human health management.

The seventh article, "Multimodal feature-wise co-attention method for visual question answering" [7], proposed a feature-wise attention mechanism for visual question answering (VQA) to extract more discriminative representations for image and question modalities. The authors designed novel modules to model the inter-modal feature-wise attention, and combine the visual spatial attention with feature-wise attention to develop a new network model for VQA. The experimental results demonstrated that the proposed approach achieved the state-of-the-art performance on two large-scale, real-world VQA datasets.

The eighth article titled "An analysis model of diagnosis and treatment for COVID-19 pandemic based on medical information fusion" [8] proposed an analysis model of diagnosis and treatment for COVID-19 based on real-world clinical data. They constructed the heterogeneous information network to discover the complex relationships among the syndromes, symptoms, and medicines. Then, the Skip-Gram model was used to generate the numerical symptom (medicine) embeddings, which were divided into seven communities (syndromes) by Spectral Clustering algorithm. From the experimental results, the authors proved that this model could effectively identify the critical symptoms and symptom distribution for diagnosis. It could provide tremendously valuable guidance for combatting the COVID-19.

In the nineth article, "Incremental learning for exudate and hemorrhage segmentation on fundus images" [9], on the Diabetic Retinopathy (DR) lesion segmentation problem, a novel incremental segmentation paradigm was proposed to distill the knowledge of the previous model to improve the current model. Remarkably, it proposed various approaches working on the class-based alignment of the probability maps of the current and the previous model, accounting for the difference between the background classes of the two models.

IoT based control of disease spread as an application of e-health can play a vital role in countering rapidly spreading diseases that can effectively manage health emergency scenarios like pandemics. It requires monitoring the Standard operating procedure (SOP) follow-up of the population in the disease-prone area with a cost-effective reporting and responding mechanism to register any violation. The last article titled "SPICE-IT: Smart COVID-19 pandemic controlled eradication over NDN-IoT" [10] proposed a solution to counter these challenges, smart COVID-19 pandemic-controlled eradication over NDN-IoT (SPICE-IT) mechanism, including autonomous SOP monitoring in indoor environments with efficient pull-based reporting mechanism that records violations at local servers and cloud server.

In conclusion, we express our gratitude to the authors for their excellent contributions to this Special Issue. We are thankful for all reviewers dedicating their efforts in reviewing these papers, and for their valuable comments and suggestions that significantly improved the quality of the articles. We also would like to acknowledge the guidance from the Editor-in-Chief and staff members. We hope that this Special Issue will serve as good reference for researchers, scientists, engineers and academicians in the field of information fusion.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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