Recent Progress on the Intelligent Computing for Multimodal Information



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Published online: 24 July 2020 © Springer Science+Business Media, LLC, part of Springer Nature 2020

1 Editorial

The world is coming to the intelligent era, and intelligent computing is now applied in almost all research domains today [1, 2]. Multimodal information, which is a set of information to map real individual or phenomena, has a trend to instead of traditional monomodal information because of its better expression. In this way, study of intelligent computing for multimodal information has acted as an important research domain in science research and industrial application [3]. Therefore, it is the time to expand more and deeper intelligent computing methods for this kind of information. Currently, there are many remaining issues are waiting for solutions in this area, such as harmonization and understandability of intelligent computing methods, fusion of vision, speech, semantics and emotions in multimodal computing, et al. [4, 5]. These entire problems need our more attention to solve. In this way, this issue aims to provide an opportunity for researchers to publish their gifted theoretical and technological studies of advanced intelligent methods for multimodal information, and their novel engineering applications within this domain. This editorial is divided into two sections, which aims to generalized method in the first section, as well as models of real multimodal information in the second section.

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2 Novel intelligent computing methods

The first section of this issue includes six papers, which focuses on the novel intelligent computing methods, such as novel deep learning models, filters and classifications [6–11].

The first article, "Semi-supervised Subspace Learning for Pattern Classification via Robust Low Rank Constraint", authored by Hailong Jiang from the Department of Computer Science, Kent State University, USA, presented a novel semi-supervised learning model that is capable of utilizing labeled and unlabeled training data simultaneously to learn discriminative feature subspace while preserving their locality. The learned feature subspace and the complete label are combined. Then, the learned representation coefficients are used to generate a dynamic neighbor graph for designing the locality preservation constraints on both of label propagation and feature subspace, and the prediction and true label are used to enforce the discrimination of feature subspace in the semantic space. Extensive experiment indicates that the approach is more competitive than other comparison methods, while the model shows more robustness when training datasets are contaminated with noise.

The second article, "A Respiratory Motion Prediction Method Based on Improved Relevance Vector Machine", authored by Qi Fan from Harbin University of Science and Technology, China, proposed a improvement of relevance vector machine, which is able to first forecast the three dimensions of respiratory movement respectively in virtue of offline training. Then the output results will be sent into multi-task Gaussian process model simultaneously to correct prediction error with the correlation between three-dimensional data and dynamically updating the training set, thus eventually realizing 3D real-time prediction of respiratory movement. The experimental results indicate that the prediction accuracy has been significantly improved.

The third article, "Research on Fault Feature Extraction and Recognition of Rolling Bearings", authored by Guochun Xu from the Ship and Ocean Engineering Department, Ningbo University, China, adopted the traditional fault feature extraction method to optimize the nonlinear and nonstationary characteristics of bearing vibration signals for fault diagnosis of rolling bearings. In addition, this paper proposed a novel signal fingerprint identification fault type in order to improve the performance of fault diagnosis. The simulation result shows that the new method is successful and effective, and the recognition rate can be improved up to 95.33%, which is better than the traditional methods.

The forth article, "Intelligent Channel Parameter Estimation System Based on Neural Network Regression Model", authored by Lantu Guo from China Research Institute of Radiowave Propagation, Qingdao, China, constructed an intelligent channel parameter estimation system on the basis of the detailed analysis of chirp signal and fractional Fourier transform. This method reduces the estimation error of Doppler shift by building and training the regression model of multilayer fully connected neural network. The simulation results show that the hierarchical channel estimation algorithm improves the precision of channel parameter estimation and the anti-noise performance of the system.

The fifth article, "Comprehensive Analysis of Deep Learning Methodology in Classification of Leukocytes and Enhancement using Swish Activation Units", authored by B A Harshanand from the Department of Analytics, School of Computer Science and Engineering, Vellore Institute of Technology, India, compared various architectures and discussed the behaviour and impact of different hyperparameters and proposed a novel methodology by incorporating recently developed swish activation to enhance the results. Unlike previously proposed methods of proposing single better neural network model this paper suggests a good choice of modular changes that could be incorporated in future works to enhance their results.

The sixth article, "Classifiers protected against attacks by fusion of Multi-branch perturbed GAN", authored by Jing Gao from the College of Computer and Information Engineering, Inner Mongolia Agricultural University, China, proposed a new technique to eliminate interference using GAN, called multi-branch perturbed GAN (MBP-GAN). MBP-GAN minimizes the input feature flow graph in generator noise filtering by introducing multi-branch fusion perturbations. This makes the sample of the generator more aware of this perturbation, thereby improving the ability of the generator and discriminator to resist classification against attacks in combat training. The paper validates the experimental results on MNIST, F-MNIST and CelebA datasets. The results show that MBP-GAN can effectively eliminate the interference from the classification against the attack.

3 Computational system for multimodal information

Then, the second section of this issue includes the other six papers, which focuses on the computational system for multimodal information, such as wireless communication, ocean multimodal information, as well as various kinds of images [12–17].

The seventh article, "GPS Interference Signal Recognition Based on Machine Learning", authored by Jie Xu from with the School of Information and Control Engineering, China University of Mining and Technology, China, focused on three typical GPS interference signals by extracting four different entropy features including power spectral entropy, establishing a hybrid entropy dataset, and using support vector machine (SVM) and random forest (RF) methods so as to classify and identify the dataset. The results show that the RF has a high recognition rate for the interference signal, which greatly exceeds the SVM. Also, in the three kinds of interference signals, the noise FM interference is the least concealed and the most easily recognized.

The eighth article, "Doppler compensation of Orthogonal frequency division multiplexing for Ocean Intelligent Multimodal information technology", authored by Zhiqiang Wu from the Department of Electrical Engineering, Wright State University, USA, proposed a method based on wavelet function to compensate for the Doppler distortions of the underwater acoustic channel for OFDM data. This method uses a set of orthogonal polynomials to perform channel estimation in both the time and frequency domains and uses the matched filtering for channel equalization. Compared with the traditional polynomials, the smoothly varying polynomials in Wavelet FFT greatly reduces the correlation of the processed data, enable more accurate channel estimation and equalization.

The ninth article, "Research on Fingerprint Identification of Wireless Devices Based on Information Fusion", authored by Changbo Hou from the College of Information and Communication Engineering, Harbin Engineering University, China, proposed a multi-segment fusion recognition model based on D-S evidence theory to overcome the shortcomings of traditional radio frequency fingerprint recognition methods. This article used the fusion features of timedomain RF-DNA and higher-order spectrum features to obtain more accurate radio frequency fingerprint features. Simulation experiments show that the fusion method can significantly improve the recognition performance of traditional fingerprint recognition methods. When the SNR is higher than 5 dB, with the increasing number of signal fusion segment, the recognition rate of the proposed model will be higher than 99%, which prove that it has a better performance and can be used in practice.

The tenth article, "Local Statistics-based Speckle Reducing Bilateral Filter for Medical Ultrasound Images", authored by Karamjeet Singh from the Department of Computer Science and Engineering, Thapar Institute of Engineering and Technology, India, designed a new speckle denoising filter which is based on local statistics, Chi-square-based distance measure and box-based kernel function in bilateral filter framework for application and use in real time. The proposed speckle denoising scheme is tested on various synthetic, Bmode, simulated and real ultrasound images. The proposed LSBF method is compared with existing speckle noise reduction methods and experimental results demonstrate that, the proposed LSBF method has better noise removing and structure preserving capability as compared to existing standard denoising filters for speckle noise.

The eleventh article titled "Adaptive Enhancement Method for Multimode Remote Sensing Image based on Lidar", authored by Khan Muhammad from the Department of Software, Sejong University, Republic of Korea, proposed a self-adaptive enhancement method for multimode remote sensing images on the basis of lidar. Color variance is used as a distance measure of multimode remote sensing image, and the multimode remote sensing image is obtained by combining the nearest neighbor region map with the region adjacent graph segmentation. Noise reduction of texture region and connection area is completed by using an adaptive threshold method, and the improved fuzzy contrast operator is used to enhance edge and texture of the image. Experimental results show that the improved method has higher enhancement resolution and larger overall information entropy, which has better enhancement effect on multimode remote sensing images.

The twelfth article, "Encryption technology of voice transmission in mobile network based on 3DES-ECC algorithm", authored by Marcin Woźniak from the Faculty of Applied Mathematics, Silesian University of Technology, Poland, designed an improved voice signal collector, which combines 3DES and ECC algorithm to realize the encryption of voice transmission information. In the process of encryption, 168bit random key is generated first, and it is grouped according to 56 bits as 3DES key, and then the plaintext is encrypted by the key to generate ciphertext; the random key is encrypted by ECC public key of the receiver. The experimental results show that the encryption time of this method is less than 1 s, the data integrity is 93%, and the data loss rate is only 0.33%. And it has better anti attack ability, fast encryption speed and good encryption effect.

Acknowledgements The guest editors are thankful to our reviewers for their effort in reviewing the manuscripts. We also thank the Edit-in-Chief, Dr. Imrich Chlamtac for his supportive guidance during the entire process. The special issue is sponsored by the Natural Science Foundation of Hunan Province under Grant 2020JJ4434, the Key Scientific Research Projects of Department of Education of Hunan Province with No.19A312; Hunan Provincial Science & Technology Project Foundation (2018TP1018, 2018RS3065), National Natural Science Foundation of China with No. 61502254, Open Project Program of the State Key Lab of CAD&CG under Grant A1926, Zhejiang University.

References

- Liu S, Wang S, Liu X, Lin CT, Lv Z (2020) Fuzzy detection aided real-time and robust visual tracking under complex environments. IEEE Trans Fuzzy Syst:1. https://doi.org/10.1109/TFUZZ.2020. 3006520
- Liu S, Guo C, Fadi A et al (2020) Reliability of response region: a novel mechanism in visual tracking by edge computing for IIoT environments. Mech Syst Signal Process 138:106537
- 3. Wei W, Bin Z, Dawid P et al (2019) A regional adaptive variational PDE model for computed tomography image reconstruction. Pattern Recogn 92:64–81
- Li S, Zhang Z, Cheng X (2020) Reliability analysis of air traffic network from network structure to transport function. Appl Sci 10(9):3168
- Mobin M, Li Z, Cheraghi S, et al. An approach for design Verification and Validation planning and optimization for new product reliability improvement, 2019, 190, UNSP 106518
- Ao L, Ruoqi A, Deyun C, et al. Semi-supervised Subspace Learning for Pattern Classification via Robust Low Rank Constraint, Mobile Networks and Applications, 2020,
- Qi F, Xiaoyang Y, Yanqiao Z, et al. A Respiratory Motion Prediction Method Based on Improved Relevance Vector Machine, Mobile Networks and Applications, 2020
- Fan S, Guochun X. Research on Fault Feature Extraction and Recognition of Rolling Bearings, Mobile Networks and Applications, 2020
- Lantu G, Yanan L, and Wenxin L, Intelligent Channel Parameter Estimation System Based on Neural Network Regression Model, Mobile Networks and Applications, 2020
- Harshanand BA, Sangaiah AK (2020) Comprehensive analysis of deep learning methodology in classification of leukocytes and enhancement using swish activation units, Mobile networks and applications
- 11. Jianjun H, Mengjing Y, Qingzhen X, et al (2020) Classifiers protected against attacks by fusion of Multi-branch perturbed GAN, Mobile Networks and Applications
- Jie X, Shuangshuang Y, Hui L (2020) GPS Interference Signal Recognition Based on Machine Learning, Mobile Networks and Applications
- Xuefei M, Tingting W, Lei L, et al (2020) Doppler compensation of Orthogonal frequency division multiplexing for Ocean Intelligent Multimodal information technology, Mobile Networks and Applications
- Qiao T, Jicheng J, and Changbo H (2020) Research on Fingerprint Identification of Wireless Devices Based on Information Fusion, Mobile Networks and Applications
- Karamjeet S, Bhisham S, Jaiteg S, et al (2020) Local Statisticsbased Speckle Reducing Bilateral Filter for Medical Ultrasound Images, Mobile Networks and Applications
- Xuechao Z, Khan M (2020) Adaptive Enhancement Method for Multimode Remote Sensing Image based on Lidar, Mobile Networks and Applications
- Zhixian C, and Marcin W (2020) Encryption technology of voice transmission in mobile network based on 3DES-ECC algorithm, Mobile Networks and Applications

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