

Editorial: Evolution from AI, IoT and Big Data Analytics to Metaverse

MengChu Zhou, *Fellow, IEEE*

Time flies. Since I took over the Editor-in-Chief position from this journal's founding Editor-in-Chief, Professor Fei-Yue Wang in 2018, five years has past just like a second. Looking back from today, as a team, we, including editorial board members, editorial staff members, our early career advisory board members, all contributing authors and all reviewers, should be proud of what this journal has achieved. This journal is the first of its kind of journals, resulting from IEEE's collaboration with Chinese Association of Automation-an outside-USA professional organization/institution. We have overcome many barriers and difficulties, and well proven that we, united and working together, can accomplish a challenging mission. We indeed set a great example for IEEE and its many societies to pursue more and more collaboration with other publishers, organizations and institutions from not only China but also such countries as India, Brazil, and Japan.

As shown in Fig. 1, IEEE/CAA Journal of Automatica Sinica (JAS) has attracted from 2017's 241 submissions to this year's 1600 ones, over six-time increment, and 84 published articles to 206 ones. Its page count has increased from 816 in 2017 to 2200 this year and its issue count increases from 4 to 12. In 2020, we received its first Impact Factor and entered the class of Q1 journals among SCI-indexed journals. In 2022, JAS has its current Impact Factor of 7.847 placing it as the top 7 among all 63 automation/control systems journals. Its CiteScore (Scopus-a database including all engineering and science related journals and conferences) has grown from 1.9 in 2017 to 13.0 in 2021, which places it as the top journal in Control and Optimization among 118 journals, top 14 among 270 Control and Systems Engineering journals, top16 among 353 Information Systems ones, and top 20 among 269 Artificial Intelligence journals.

Human beings can well evolve because they are able to create new tools, new methods, new concepts, new technologies and new products that benefit human being themselves as well as move our entire human society and world forward. Our JAS has to evolve as well despite that it has progressed well with great success. An academic journal's vitality and impact lie in maintaining and promoting the depth and breadth of its targeted academic fields as well as standards and operability of specialized knowledge and technical knowhow. Its mis-

sions include a) the promotion of new academic thoughts, new theory, new methodologies and new applications; and b) the cultivation and spread of new and emerging research directions and technologies. The entire editorial board, especially founding Editor-in-Chief, Professor Fei-Yue Wang, the coming Editor-in-Chief, Professor Qing-Long Han and I, have strong agreement on such understanding. JAS initially published papers and editorials only. To meet the demands of authors and readers, we have created two new categories: Letter and Perspective. The former serves as a fast way to publish important and often single important contribution or discovery in the broad field of automation. The latter allows the brand new ideas and sometimes controversial ideas to be published in a timely fashion, that could revolutionize an existing area or establish a completely new area. For example, this issue has a special section presenting five Perspective articles, which well explore various metaverses and their applications. These articles have well covered such important and metaverse-related technologies as digital twins, parallel intelligence, CPSS, CPSI, DAO, Big AI and Foundation models, especially their implications and potentials in intelligent control and automation [1], [2]. Here, we especially acknowledge Prof. Fei-Yue Wang's efforts in making this section possible. We hope that more researchers and practitioners would contribute their Perspectives to JAS, thus making JAS a truly effective forum for the exchange of new ideas and emerging technologies to advance the state of the art in automation.

Metaverse can be viewed as a virtual-reality space in which human beings can interact with computer-generated environments, all agents and other human beings. They evolve from such technologies as Artificial intelligence (AI) [3]–[5], Internet of Things (IoT) [6]–[8], Big Data Analytics [9]–[11] and many other related ones.

Artificial intelligence (AI) refers to human-made intelligence in various machines and systems that can think, work and act like human beings. It enables such machines and systems to rationalize and take the most appropriate actions to accomplish their missions or pre-set goals.

The Internet of Things (IoT) is a network of all physical objects named “things” that are embedded with sensors, communications, networking and other technologies for the purpose of connecting and exchanging data/information/knowledge with other devices and systems over available networking infrastructure. Their applications cover every facet of human life and each industrial sector. They generate enormous data that lead to big data.

Big data often refers to data that contains many Varieties,

Citation: M. Zhou, “Editorial: Evolution from AI, IoT and big data analytics to metaverse,” *IEEE/CAA J. Autom. Sinica*, vol. 9, no. 12, pp. 2041–2042, Dec. 2022.

M. Zhou is with the Helen and John C. Hartmann Department of Electrical and Computer Engineering, New Jersey Institute of Technology, Newark, NJ 07102 USA (e-mail: zhou@njit.edu).

Digital Object Identifier 10.1109/JAS.2022.106100

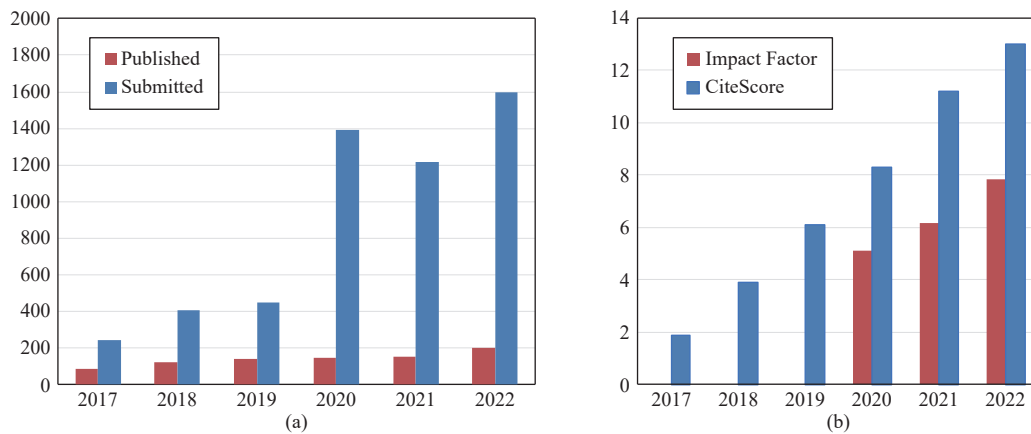


Fig. 1. The recent performance of IEEE/CAA Journal of Automatica Sinica (JAS): (a) published and submitted paper counts and (b) Impact Factor (Web of Science) and CiteScore (Scopus).

arrives in enormous Volumes and high Velocity with its Veracity (the “truth” or accuracy of data and information assets) and value (to help the optimal operations of machines, systems, companies, institutions and governments), which are noted as the five Vs. The resulting dataset is too large and too complex to be handled by traditional data-processing hardware and software. Handling big data is a huge challenge due to the high difficulty in acquiring, storing, analyzing, searching, sharing, transferring, visualizing, querying, updating, and protecting the privacy of data and information. They often need cloud, edge and fog computing technologies [12]–[15] and AI/machine learning algorithms to deal with it such that useful information and knowledge can be extracted from it.

In addition to the above mentioned AI, IoT and big data analytics, some specific technologies that support metaverses includes virtual reality (VR) headsets, augmented reality (AR) glasses, adequate bandwidth, and interoperability standards. The applications of metaverses to industrial automation, agriculture, health care, etc. are forthcoming. They promise to greatly benefit human beings in the coming years.

As a final note, on behalf of editorial members and staff, I welcome Prof. Qing-Long Han to continue this enjoyable and happy journey to move JAS to a new level. He has accumulated the tremendous experience in handling top-class journals. Passing this journal to his hand would surely make me relaxed. Working together and working hard, we should make a better and better JAS.

REFERENCES

- [1] F.-Y. Wang, “The DAO to MetaControl for MetaSystems in Metaverses: The System of Parallel Control Systems for Knowledge Automation and Control Intelligence in CPSS,” *IEEE/CAA Journal of Automatica Sinica*, vol. 9, no. 11, pp. 1899–1908, 2022.
- [2] F. -Y. Wang, “The Metaverse of Mind: Perspectives on DeSci for DeEco and DeSoc,” *IEEE/CAA Journal of Automatica Sinica*, vol. 9, no. 12, pp. 2043–2046, 2022.
- [3] Y. Ma, Z. Wang, H. Yang, and L. Yang, “Artificial intelligence applications in the development of autonomous vehicles: a survey,” *IEEE/CAA Journal of Automatica Sinica*, vol. 7, no. 2, pp. 315–329, Mar. 2020.
- [4] M. Ghahramani, Y. Qiao, M. Zhou, A. O Hagan, and J. Sweeney, “AI-based modeling and data-driven evaluation for smart manufacturing processes,” *IEEE/CAA J. Autom. Sinica*, vol. 7, no. 4, pp. 1026–1037, Jul. 2020.
- [5] H. Liu, I. Chatterjee, M. Zhou, X. S. Lu, and A. Abusorrah, “Aspect-based Sentiment Analysis: A Survey of Deep Learning Methods,” *IEEE Trans. on Computational Social Systems*, vol. 7, no. 6, pp. 1358–1375, Dec. 2020.
- [6] O. Friha, M. A. Ferrag, L. Shu, L. Maglaras, and X. Wang, “Internet of Things for the Future of Smart Agriculture: A Comprehensive Survey of Emerging Technologies,” *IEEE/CAA Journal of Automatica Sinica*, vol. 8, no. 4, pp. 718–752, Apr. 2021.
- [7] G. Fortino, C. Savaglio, G. Spezzano, and M. Zhou, “Internet of Things as System of Systems: A Review of Methodologies, Frameworks, Platforms, and Tools,” *IEEE Trans. on Systems, Man, and Cybernetics: Systems*, vol. 51, no. 1, pp. 223–236, Jan. 2021.
- [8] G. Fortino, W. Russo, C. Savaglio, W. Shen, and M. Zhou, “Agent-Oriented Cooperative Smart Objects: From IoT System Design to Implementation,” *IEEE Trans. on Systems, Man, and Cybernetics: Systems*, vol. 48, no. 11, pp. 1939–1956, Nov. 2018.
- [9] H. Zahid, T. Mahmood, A. Morshed, and T. Sellis, “Big data analytics in telecommunications: literature review and architecture recommendations,” *IEEE/CAA Journal of Automatica Sinica*, vol. 7, no. 1, pp. 18–38, Jan. 2020.
- [10] S. Imran, T. Mahmood, A. Morshed, and T. Sellis, “Big data analytics in healthcare – A systematic literature review and roadmap for practical implementation,” *IEEE/CAA Journal of Automatica Sinica*, vol. 8, no. 1, pp. 1–22, Jan. 2021.
- [11] X. Luo, M. Zhou, S. Li, D. Wu, Z. Liu, and M. Shang, “Algorithms of Unconstrained Non-Negative Latent Factor Analysis for Recommender Systems,” *IEEE Trans. on Big Data*, vol. 7, no. 1, pp. 227–240, 1 Mar. 2021.
- [12] H. Yuan and M. Zhou, “Profit-Maximized Collaborative Computation Offloading and Resource Allocation in Distributed Cloud and Edge Computing Systems,” *IEEE Transactions on Automation Science and Engineering*, vol. 18, no. 3, pp. 1277–1287, Jul. 2021.
- [13] P. Zhang, M. Zhou, and G. Fortino, “Security and trust issues in Fog computing: A survey,” *Future Generation Computer Systems*, vol. 88, pp. 16–27, Nov. 2018.
- [14] P. Zhang and M. Zhou, “Dynamic Cloud Task Scheduling Based on a Two-Stage Strategy,” *IEEE Transactions on Automation Science and Engineering*, vol. 15, no. 2, pp. 772–783, Apr. 2018.
- [15] Q.-H. Zhu, H. Tang, J.-J. Huang, and Y. Hou, “Task Scheduling for Multi-Cloud Computing Subject to Security and Reliability Constraints,” *IEEE/CAA Journal of Automatica Sinica*, vol. 8, no. 4, pp. 848–865, Apr. 2021.