Theory and Practice of Science and Technology
2025, VOL. 6, NO. 5, 9-13
DOI: 10.47297/taposatWSP2633-456902.20250605

Research on Collaborative Innovation of Aerospace Information Network and Intelligent Communication Technology

Yuanzhi Li

University of the West of Scotland, Paisley, United Kingdom, PA1 2BE

ABSTRACT
With the rapid development of information technology, aerospace information networks and intelligent communication technologies have become the key forces promoting social progress and technological transformation. This paper deeply explores the background and significance of collaborative innovation between aerospace information networks and intelligent communication technologies, analyzes the current development status and challenges of both, expounds the theoretical basis and key technologies of collaborative innovation, proposes the models and paths of collaborative innovation, and looks forward to the future development trends, aiming to provide references for research and practice in related fields.

KEYWORDS
Aerospace Information Network; Intelligent Communication Technology; Collaborative Innovation

1 Introduction

In today's digital age, the rapid development of information technology is profoundly changing people's ways of life and work. As an information transmission and processing platform integrating space and ground, the aerospace information network has advantages such as wide coverage, large communication capacity and strong anti-destruction ability, and plays an important role in military, civilian and other fields. From a military perspective, the aerospace information network can provide real-time intelligence, command and control support for military operations, and achieve global military information sharing and collaborative operations. In the civilian sector, it provides efficient information services for fields such as aviation, navigation, weather forecasting, and disaster monitoring, greatly enhancing the operational efficiency of society and the ability to respond to emergencies [1].

Intelligent communication technology, with its powerful data processing capabilities, adaptability and intelligent decision-making capabilities, provides new possibilities for the performance improvement and application expansion of communication systems [2]. For example, in mobile communication networks, intelligent communication technology can achieve the dynamic allocation of network resources, automatically adjust the resource allocation strategy according to the demands of users and the network load conditions, and improve network efficiency and user experience [3]. Meanwhile, intelligent communication technology can also be applied in the field of the Internet of Things to achieve intelligent interconnection and collaborative work among devices, promoting the wide application and development of the Internet of Things [4].

The collaborative innovation of aerospace information networks and intelligent communication technologies can achieve complementary advantages of both, promote the leapfrog development of information technology, and meet the growing demands for information transmission and processing. On the one hand, intelligent communication technology can provide more efficient and intelligent signal processing and resource allocation schemes for aerospace information networks [5], improving the performance and reliability of aerospace information networks; On the other hand, the aerospace information network can provide broader application scenarios and richer data resources for intelligent communication technologies, promoting their further development and innovation [6]. Therefore, conducting collaborative innovation research on aerospace information networks and intelligent communication technologies has significant practical significance and strategic value.

2 The Current Development Status and Challenges of Aerospace Information Networks and Intelligent Communication Technologies

2.1 Current Development Status of Aerospace Information Networks

The aerospace information network is mainly composed of satellite communication systems, near-space communication systems and aviation communication systems, etc. [7] At present, multiple satellite communication systems have been established worldwide, such as the satellite communication network of the International Maritime Satellite Organization and China's Beidou Satellite Navigation System, providing significant support for communication, navigation and positioning services on a global scale. These satellite communication systems play an irreplaceable role in

fields such as maritime communication, aviation communication, and emergency rescue[8]. For example, in maritime communication, satellite communication systems can provide stable communication services for ships, ensuring the safe navigation of ships and the life safety of crew members.

Near-space communication systems, such as stratospheric airships and high-altitude balloons, have also made certain research progress and have potential application value. Stratospheric airships have the characteristics of long-term presence in the air and wide coverage, and can be used in fields such as regional communication and environmental monitoring. However, the development of near-space communication systems still faces some technical challenges, such as the attitude control of airships and energy supply issues.

The aviation communication system is also constantly developing, and new-generation aviation communication technologies such as aviation Internet and airborne broadband communication are gradually being applied. Aviation Internet can provide passengers with high-speed Internet access services and improve their flight experience. However, aviation communication systems are also confronted with problems such as signal interference and communication security.

2.2 Current Development Status of Intelligent Communication Technology

Intelligent communication technology covers multiple fields such as artificial intelligence, machine learning, and big data, and has been widely applied in aspects such as signal processing, resource allocation, and network optimization in communication systems. For example, the channel estimation technology based on deep learning can improve the accuracy of signal transmission. By training the neural network model, the channel state information can be estimated more accurately, thereby improving the demodulation performance of the signal [9]. The intelligent resource allocation algorithm can dynamically adjust resource allocation according to the network load situation to improve network efficiency. Reinforcement learning algorithms have been widely applied in resource allocation. Through the interactive learning between agents and the environment, the optimal allocation of resources is achieved.

However, intelligent communication technology is also confronted with problems such as data privacy protection, algorithm interpretability, and high computational complexity. In terms of data privacy protection, as intelligent communication technologies rely more and more on data, how to ensure the security and privacy of user data has become an urgent problem to be solved. The interpretability of algorithms is also an important challenge faced by intelligent communication technologies. Some complex machine learning algorithms often have difficulty explaining their decision-making processes, which limits their application scope to a certain extent.

2.3 Common Challenges Faced

Both aerospace information networks and intelligent communication technologies are confronted with some common challenges during their development process. On the one hand, with the explosive growth of information volume, higher requirements have been put forward for the capacity and transmission rate of communication systems. Traditional communication technologies have been unable to meet the growing demand for information transmission, and new technologies and methods need to be developed to improve the performance of communication systems. On the other hand, the network environment is becoming increasingly complex and network security issues are becoming more prominent. How to ensure the secure transmission and processing of information has become an urgent problem to be solved. Both aerospace information networks and intelligent communication systems are confronted with security threats such as cyber attacks and information leaks, and it is necessary to strengthen the research and application of cyber security protection technologies. In addition, the unification and compatibility of technical standards are also important factors restricting the development of both. Different aerospace information networks and intelligent communication technologies may adopt different technical standards and protocols, resulting in poor interoperability among systems and affecting the sharing and exchange of information.

3 Theoretical Basis and Key Technologies of Collaborative Innovation

3.1 Theoretical Basis

The theory of collaborative innovation emphasizes cooperation and synergy among different entities. By integrating resources, knowledge and technologies from all parties, it aims to enhance innovation capabilities and share innovation achievements. In the collaborative innovation of aerospace information networks and intelligent communication technologies, it is necessary for all parties including the government, enterprises and research institutions to participate together, and form an innovation system that combines industry, academia, research and application. The government can formulate relevant policies and plans to guide and support the development of collaborative innovation. Enterprises

can play the role of market entities and invest funds and human resources in technological research and development and product promotion. Research institutions can carry out research on cutting-edge technologies and provide technical support for collaborative innovation. Meanwhile, the principles of openness, sharing, mutual benefit and win-win should be followed to promote the flow and optimal allocation of factors such as technology, talent and capital. By establishing an open innovation platform, the sharing and exchange of technological achievements can be achieved, the efficiency of innovation can be improved, a sound intellectual property protection mechanism can be established, the legitimate rights and interests of innovation entities can be protected, and the enthusiasm for innovation can be stimulated.

3.2 Key Technologies

The space-ground integrated network convergence technology realizes the seamless integration of the space-air information network and the ground communication network, breaks the information barriers between the earth and the ground, and improves the coverage of the network and the reliability of communication. This requires solving problems such as protocol compatibility, spectrum sharing and resource scheduling among different networks. For example, Software-defined Networking (SDN) and Network Function Virtualization (NFV) technologies are adopted to achieve flexible scheduling and management of network resources.

Intelligent signal processing technology utilizes artificial intelligence and machine learning algorithms to intelligently process signals in space-air information networks, including signal detection, estimation, modulation and demodulation, etc., thereby enhancing the quality and efficiency of signal transmission. For example, using deep neural networks for channel equalization can effectively resist channel fading and interference.

Adaptive resource allocation technology intelligently allocates network resources, such as spectrum resources and power resources, based on the dynamic changes of the aerospace information network and user demands, to improve the utilization rate of resources and network performance. The adaptive and optimal allocation of resources can be achieved through the reinforcement learning algorithm, and the resource allocation strategy can be adjusted in real time according to the changes of the network state.

Network security protection technology, in response to the network security threats faced by aerospace information networks, such as network attacks and information leaks, adopts advanced encryption technology, intrusion detection technology and security authentication technology to ensure the safe and stable operation of the network. For instance, the adoption of quantum encryption technology can enhance the security of communication and prevent information from being stolen or tampered with.

4 Models and Paths of Collaborative Innovation

4.1 Collaborative Innovation Model

Joint research and development teams should be established among scientific research institutions, universities and enterprises to jointly carry out key technology research on aerospace information networks and intelligent communication technologies. All parties give full play to their own advantages to achieve the sharing of technical resources and complementary advantages. For instance, research institutions can offer cutting-edge theoretical research and technical support, while enterprises can provide practical engineering application requirements and testing environments.

Form an industrial alliance for aerospace information networks and intelligent communication technologies, integrate the resources of enterprises in the upstream and downstream of the industrial chain, jointly formulate technical standards and promote industrial development. Industrial alliances can carry out joint marketing promotion, talent cultivation and other activities to enhance the overall competitiveness of the industry. For instance, industrial alliances can jointly conduct market research, formulate unified product standards, and enhance the compatibility and interoperability of products.

Market demand-oriented, the government, enterprises, research institutions and users jointly participate in the innovation process. Research institutions and universities are responsible for technological research and development as well as talent cultivation. Enterprises are responsible for product research and development, production and sales. Users provide feedback and demands. The government offers policy support and guidance. For instance, the government can encourage collaborative innovation among all parties involved in industry, academia, research and application by setting up scientific research projects and offering tax incentives.

4.2 Collaborative Innovation Path

The government should formulate a strategic plan for the collaborative innovation of aerospace information networks

and intelligent communication technologies, clarify development goals and key tasks, and strengthen policy guidance and financial support. For example, formulate relevant industrial policies, science and technology policies, etc., and guide resources to gather in the field of collaborative innovation. Establish a long-term mechanism for cooperation among industry, academia, research and application, and enhance communication and collaboration among all parties. Encourage enterprises to jointly build research and development centers, laboratories and other innovation platforms with scientific research institutions and universities to promote the transformation of scientific and technological achievements. For instance, enterprises can jointly establish postdoctoral workstations with universities to attract outstanding talents to participate in the research and development work of the enterprises.

Strengthen the cultivation of talents in the field of aerospace information networks and intelligent communication technologies, and cultivate high-quality talents with interdisciplinary knowledge and innovation capabilities. Colleges and universities should adjust the professional Settings and curriculum systems, strengthen the practical teaching links, and improve students' practical ability and innovation ability. Actively participate in the cooperation and exchange of international aerospace information networks and intelligent communication technologies, and introduce advanced foreign technologies and management experiences. Strengthen cooperation with international organizations and other countries to jointly carry out scientific research projects and the formulation of technical standards.

5 Outlook on Future Development Trends

5.1 Trends in Technology Convergence

In the future, aerospace information networks and intelligent communication technologies will achieve a deeper integration. Artificial intelligence, big data, the Internet of Things and other technologies will interpenetrate and promote each other with aerospace information networks and intelligent communication technologies, forming a more intelligent, efficient and secure information and communication system. For instance, artificial intelligence technology will further optimize the resource allocation and signal processing algorithms of the aerospace information network, enhancing the performance and intelligence level of the network.

5.2 Application Expansion Trends

The collaborative innovation of aerospace information networks and intelligent communication technologies will be applied in more fields. In addition to the traditional military and civilian communication fields, it will also play an important role in intelligent transportation, smart cities, emergency rescue and other fields. For instance, in the field of intelligent transportation, real-time communication and collaborative control among vehicles can be achieved through the space-air information network, thereby enhancing traffic efficiency and safety.

5.3 Trends in Industrial Ecosystem Development

With the in-depth advancement of collaborative innovation, the aerospace information network and intelligent communication technology industry will form a more complete industrial ecosystem. Cooperation among enterprises in the upstream and downstream of the industrial chain will become closer, innovative enterprises will keep emerging, and the industrial scale will continue to expand.

For instance, a complete industrial chain will be formed, ranging from chip manufacturing, equipment research and development to system integration and operation services.

6 Conclusion

The collaborative innovation of aerospace information networks and intelligent communication technologies is an important direction for promoting the development of information technology. By strengthening the collaborative innovation between the two, their respective advantages can be fully exerted, the current technical challenges can be solved, and the leapfrog development of information technology can be promoted. In the future development, it is necessary for all parties including the government, enterprises and research institutions to make joint efforts, strengthen top-level design, promote the in-depth integration of industry, academia, research and application, cultivate innovative talents, carry out international cooperation, and achieve the collaborative innovation and sustainable development of aerospace information networks and intelligent communication technologies. At the same time, we should pay attention to the future development trends, make early plans for related technologies and industries, and gain the initiative for the development of our country in the field of information and communication.

References

[1] Ni, X., Wang, H., Che, C., Hong, J., & Sun, Z. (2019). Civil aviation safety evaluation based on deep belief network and principal component analysis. Safety science, 112, 90-95.

[2] Al-Fuqaha, A., Guizani, M., Mohammadi, M., Aledhari, M., & Ayyash, M. (2015). Internet of Things: A Survey on Enabling Technologies, Protocols, and Applications. IEEE Communications Surveys & Tutorials, 17(4), 2347-2376.

[3] Capone, A., Elias, J., Martignon, F., & Pujolle, G. (2006, May). Dynamic resource allocation in communication networks. In International Conference on Research in Networking (pp. 892-903). Berlin, Heidelberg: Springer Berlin Heidelberg.

[4] Arsénio, A., Serra, H., Francisco, R., Nabais, F., Andrade, J., & Serrano, E. (2014). Internet of intelligent things: Bringing artificial intelligence into things and communication networks. Inter-cooperative collective intelligence: Techniques and applications, 1-37.

[5] Foukas, X., Patounas, G., Elmokashfi, A., & Marina, M. K. (2017). Network Slicing in 5G: Survey and Challenges. IEEE Communications Magazine, 55(5), 94 - 100.

[6] Wang, M., Li, P., & Sun, Q. (2021). Synergy between space-based information networks and intelligent communication technologies. Chinese Journal of Electronics, 30(3), 456 - 469.

[7] Liu, J., Shi, Y., Fadlullah, Z. M., & Kato, N. (2018). Space-air-ground integrated network: A survey. IEEE Communications Surveys & Tutorials, 20 (4), 2714-2741.

[8] Lutz, E., Cygan, D., Dippold, M., Dolainsky, F., & Papke, W. (1991). The land mobile satellite communication channel-recording, statistics, and channel model. IEEE transactions on vehicular technology, 40(2), 375-386.

[9] Kang, J. M., Chun, C. J., & Kim, I. M. (2020). Deep learning based channel estimation for MIMO systems with received SNR feedback. IEEE Access, 8, 121162-121181.