Application of Intelligent Technology in Operation Command Assistant Decision System

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Abstract. In previous wars, the command and decision-making were mainly based on human experience. With the development of modern high technology, the battlefield space is expanding day by day, weapons and equipment are constantly updated, the three-dimensional nature of sea, land, air, space and electricity is continuously enhanced, and the battlefield situation is changing rapidly. It is not enough to rely solely on the experience and wisdom of commanders. Starting from the definition and principle of intelligent decision-making system for operation command, this paper focuses on the research status of intelligent technology in naval vessel operation command decision-making system, expounds the difficulties and challenges faced at present, and puts forward some thoughts on the future intelligent naval warfare.

Keywords. intelligent technology, assistant decision-making, artificial intelligence, operation command

1 Introduction

The emergence and application of intelligent technology will certainly lead to a major change in the operational form. The world's major military powers, led by the United States, are developing their operational theories. Based on networks, data, knowledge and computing technologies, they are promoting the transformation from "information centric operations" to "decision-making centric operations" and from "controlling information superiority" to "controlling decision-making superiority". At present, artificial intelligence technology has made breakthrough progress in many fields such as situation awareness, intelligent decision-making, voice interaction, and cooperative operations. It is widely distributed in many fields such as unmanned combat platforms, intelligence reconnaissance, command and decision-making, network security, and electronic warfare [1]. It is an inevitable element to improve the combat effectiveness of weapon equipment and an inevitable trend of future development.

2 Intelligent decision support system for battle command

2.1 Overview of battle command aided decision making system

Intelligent decision support system [2] (IDSS) refers to a decision support system that, with the assistance of computers, comprehensively applies modern decision theory and artificial intelligence technology, combines management decision science, information science,

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operations research and other disciplines, relies on human knowledge base, and helps solve real problems through logical reasoning, as shown in Figure 1.

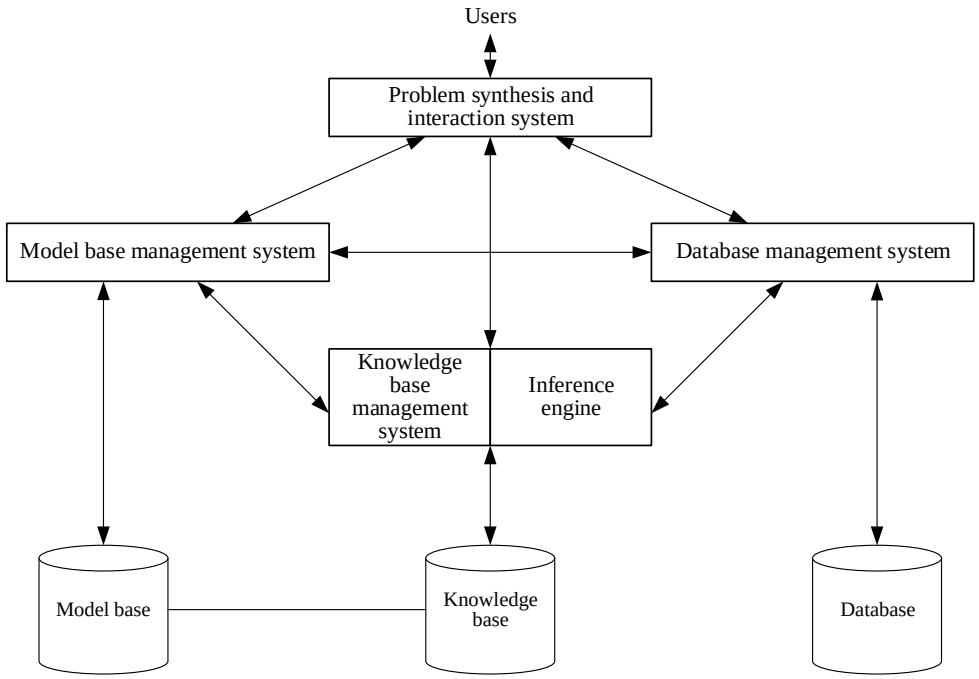

Figure.1 Composition structure of intelligent decision support system

2.2 Overview of intelligent decision support system for battle command

The battle command auxiliary decision-making system is an intelligent system with battlefield environment, operational knowledge, military expert knowledge, and self-learning and self-improvement capabilities. It can generate models for decision-making according to battlefield situation analysis, threat assessment, threat source diagnosis and other information, call relevant data and algorithms to provide alternative solutions, evaluate and optimize various solutions, and help commanders make up their minds Transmission instruction: when the execution unit receives the instruction, it will respond and act. That is to say, decision support system is a comprehensive integrated system that combines multiple models organically by using database and human-computer interaction, and assists decision makers to achieve scientific decision.

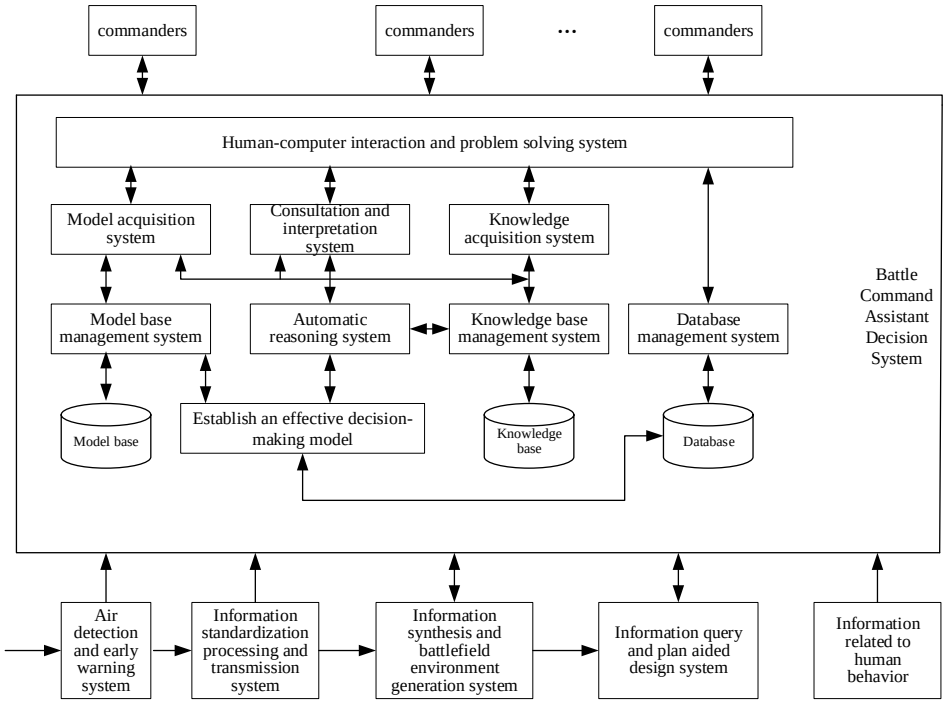

Figure.2 Architecture of intelligent decision support system for operation command

3 Research status of intelligent technology in warship battle command assistant decision system

The military intelligent technology research machine is used to complete the content related to identification, reasoning, judgment, decision-making, control, guidance, environmental adaptation and so on in military activities, which runs through the whole process of observation, judgment, decision-making and action in military activities [3].

3.1 Foreign research status

In 2019, BAE Systems of the United Kingdom put forward the concept [4] of "naval future combat system". The system applied augmented reality technology and combat decision-making technology, integrated artificial intelligence tools into the combat system, facilitated commanders to quickly process information, sped up combat decision-making, and improved the combat capability of naval vessels. In the same year, the Bureau of armaments and materials of the Spanish Ministry of Defense awarded the Soprene project contract to Indra for a period of two years. The project used the battle decision-making technology, used the neural network algorithm to process the big data information of Shipborne sensors, and used the analysis results to improve the preventive maintenance ability and ensure the reliability of ships.

Operational Panning Tool was the future Navy capability program of the United States in

fiscal 2016. The project developed a software to assist aircraft carrier strike groups and expeditionary strike groups in formulating and evaluating operational plans during their deployment, including route planning and prompting the attitude of ships in different tasks. It focused on developing a simple and effective "plan-resume-implementation-evaluation" system for decision-making officials of the aircraft carrier strike group, which could quickly adapt to changes in combat conditions and make rapid adjustments according to mission requirements. The system also provided soldiers with real-time and accurate information, and independently assisted in decision-making of navigation plans. It collected command and control, navigation and tactical data to assist commanders in making decisions quickly; At the same time, the system would also have a training function, which could train operators according to needs during deployment.

It was understood that the US Naval Research Office commissioned Charles River Analysis (CRA) to build a maritime defense tool for the US Navy's global unmanned shipboard optical information processing (TOPGUN) project [5].According to the project, CRA would continue to support TOPGUN's independent development, expand its detection and classification capabilities, use efficient deep learning algorithms to detect farther targets, identify more types of ships, and demonstrate its performance on the water. The US Navy's Surface Warfare Center developed the SWARM**-**Tac system, which aimed to make use of machine learning and artificial intelligence to formulate tactics for large warships and improve their probability of successfully defending against such cluster attacks. This AI driven technology made use of the existing sensor information on naval ships, radar and other equipment used to let commanders understand the battlefield situation, as well as the information of the ship itself, its available weapons and the number of attackers. The software integrated all this information into solutions and judged the success probability of these solutions. Researchers said that although SWARM**-**Tac was still in the R & D stage, it has achieved quite good results in a previous sea trial.

3.2 Domestic research status

Ma Y L [6] proposed a shipborne intelligent command and control architecture design. The artificial intelligence computing components in the system completed the storage of big data and the access of intelligent service applications. The intelligent training component based on deep learning takes the deep learning algorithm as the core. Aiming at the intelligent functions of the shipborne information system, such as target recognition, behaviours recognition, intention judgment and so on, it relied on the unified stored data of the intelligent computing component to complete the corresponding learning and training calculation, and stored the results in the unified data storage framework. Shipborne intelligent application components completed the application access of intelligent services and were embedded in various shipborne human-computer interaction devices.

Zhou L [7] and others introduced the deep reinforcement learning method into the battle aided decision-making process. The deep learning method was used for the learning of battlefield feature vectors, and the reinforcement learning method was used for the evaluation of decision-making states. They combined the two methods for the search of the best action decision sequence.

According to the general theory of rational decision-making of artificial intelligence, Wang T

[8] and others used the complete joint probability distribution for reasoning, adaptively modified the Kalman filter algorithm to predict the probability distribution of target position, introduced memory nodes to adaptively estimate speed and acceleration, and combined with the weapon combat effectiveness and damage degree model to provide the commander with the basis for strike decision-making.

Qian G X [9] and others analyzed the current situation and future development trend of data analysis and command decision-making of live firing of naval guns, preliminarily explored the idea of application of key artificial intelligence technologies in live firing of naval guns, and provided ideas for the combination of traditional naval gun weapons and artificial intelligence technology to promote the improvement of live firing level of naval guns.

Liu S [10] built the intelligent decision-making system framework of naval surface ships in joint operation with the agent theory and technology against the background of the sea formation confrontation between the red and blue surface ships. This paper proposes a new idea and method for the establishment of intelligent decision-making system for surface ships, which is a further extension of the research on traditional combat real-time decision-making system and has practical significance.

4 Challenges faced by the development of battle command intelligent decision support system

Although artificial intelligence technology has made breakthrough progress in the military field and has been widely applied to many platforms, we should be soberly aware that the intellectualization of the battle command auxiliary decision-making system is a long-term goal and cannot be achieved overnight. There are still many problems to be solved.

4.1 The uncertainty of war

In recent years, Jin X [11], Hu X F [12] and many other experts and scholars have conducted in-depth research on the "dark green", "dark blue" and AlphaGo systems in the United States. They were surprised to find that many problems that cannot be solved by traditional methods can be solved by artificial intelligence technology, which solves many problems. However, due to the uncertainty of battlefield situation information and the rapid change of battlefield environment, such as incomplete battlefield information, uncertain battle space, changeable tactics and other factors that are difficult to quantify, intelligent aided decision-making is far more difficult than chess. Machines can not understand complex and changeable combat situations in a regular manner like chess, which brings great challenges to intelligent aided decision-making. So at present, artificial intelligence has more advantages than human beings in recognizable and regular patterns. However, in unpredictable and fuzzy situations, artificial intelligence can not reach human cognition.

4.2 Security of intelligent software

From the perspective of intelligent algorithms, compared with commercial software, military intelligent software pays more attention to the high security and reliability of algorithms to ensure safety, especially intelligent decision-making assistance software. Taking the deep

learning, which is widely studied at present, as an example, its essence is based on data, and through feature extraction of data, the required information can be obtained. In other words, deep learning can't deal with things that have never been encountered before. Once the application scenario is different from what was "learned" before, the recognition accuracy of the learning model can't be guaranteed, and even wrong judgments will be made. It's difficult to estimate the impact on the war results. This is also one of the important reasons why the intelligent auxiliary decision-making system can't equip warships for the time being. From the perspective of security protection, it is impossible to rule out the possibility that the intelligent decision-making assistance system encounters hacker attacks and the program is modified, resulting in abnormal decision-making [13].

4.3 Validity of data information

In the era of big data, all kinds of military information are increasing rapidly, massive battlefield information is constantly emerging, tactics and tactics are flexible and changeable, and the decision-making environment is complex. As a result, it is difficult to eliminate the false and retain the true, eliminate the rough and extract the essence in decision-making analysis, and can not be effectively identified, affecting commanders to make efficient and accurate posture judgments. In addition, the data resources in the military have the problems of heterogeneous environment, data redundancy and non-uniform standards. It is difficult to extract the basic data quickly and accurately, to thoroughly analyze the information and knowledge hidden in the basic data, and to make the commander make the best decision[14]. Therefore, how to collect, mine and extract the enemy's intention, target value, battlefield situation and change trend and other situational cognitive elements from the massive battlefield information, and improve the ability from data to decision-making has increasingly become a challenge for decision makers.

5 Some thoughts

The future development trend of sea battle command will eventually be the mode of man-machine deep integration and intelligent decision-making. Intelligent technology will be fully integrated into the perception, judgment, organization, decision-making, action and defense of future sea battles, so as to meet the challenges and bottlenecks in future sea battles and change the style of future sea battles.

5.1 Strengthen theoretical research and formulate standards and regulations for intelligent decision-making software

With the development of intelligent decision-making mode, higher requirements are put forward for the standardization of intelligent decision-making software engineering. Strengthening the construction of intelligent software engineering standard system and constructing the development maturity evaluation system of intelligent decision-making software will play a key role in ensuring that intelligent decision-making software has safe and reliable decision-making ability in the complex battlefield in the future. Starting from the technical characteristics of intelligent auxiliary decision-making and engineering management, the new characteristics of intelligent software evaluation in terms of requirements, organization and conclusions are studied. According to the process methods proposed by

GJB9001C and GJB5000B, and according to regulatory documents such as test rules in the equipment field and at all levels, the airport standards, test contents, organization and implementation of evaluation are proposed, and evaluation procedures, index systems and evidence-based data systems are established, and build a twin quality evaluation method for class data. The main directions include: the evaluation requirements and process of intelligent decision-making software, the quality evaluation index set and evidence-based data system of intelligent decision-making software, the evaluation technology of intelligent decision-making software, and the evaluation standard set of intelligent decision-making software and so on.

5.2 Establish the concept of big data and improve the security protection of artificial intelligence

The future war is a systematic and networked war, which is based on information acquisition and comprehensive data processing. The complexity and real-time nature of data are enhanced. With the help of big data technology, decision makers can implement a data-driven approach, collect comprehensive data related to operations, training, management, political work and logistics, analyze and model them, and maximize the mining of valuable information. Therefore, we should establish the concept of big data, enhance the core position of big data in military decision-making, and realize the transformation from "from data to information to decision-making" to "from data to find value directly to decision-making". Strengthen the accumulation of our army's operational data and sample size, build a large-scale, complete category and clear relationship operational data system, and establish a relatively stable network system, which provides a prerequisite for improving the ability of intelligent decision-making. At the same time, we should strengthen the security and protection of artificial intelligence, formulate anti attack security strategies, build a security firewall and "anti-virus software" in the intelligent era, ensure the safe acquisition, transmission, processing and distribution of data, and achieve effective defense.

5.3 Promote key technology research and vigorously develop intelligent naval warfare equipment

The competition in future naval battles is unprecedentedly fierce. To seize the development opportunities in the military field, win the initiative in future naval battles, better apply artificial intelligence innovation technologies to intelligent naval battle modes and equipment, and improve the intelligence level of perception, judgment, organization, decision-making, action and defense, it is necessary to further develop intelligent technologies such as situational awareness, decision-making, confrontation, unmanned combat platforms, and human-computer collaborative interaction, Improve the autonomy and intelligence of combat platforms and equipment, closely integrate key elements such as forces, and tasks, and form an accurate and efficient perception-judgment-decision-action-feedback closed loop[15]. First, we should develop manned equipment for future naval battles. On the basis of mechanization and informatization, manned combat platforms such as traditional aircraft carriers, destroyers, submarines and carrier borne aircraft should deeply integrate artificial intelligence technology, achieve intelligence in manipulation, weapon use, command and decision-making, and have the ability to carry unmanned platforms efficiently and send and receive support, so as to form technical advantages and lay a good foundation for winning the war. Second, we should develop unmanned maritime equipment in the future. Thousands of unmanned equipment and thousands of unmanned clusters will participate in future naval battles. They need to focus on

autonomous / intelligent navigation and combat, and have long-term navigation ability and low life-cycle cost. They will present three major characteristics: intelligence, long endurance and low cost.

6 Concluding remarks

Many countries attach great importance to the development of intelligent weapons and the research of intelligent operations in their plans to build the armed forces of the 21st century. Whether it is the competitive and military strategic decision-making of national defense construction, or the automatic control of weapons and equipment and the automation of battle command, it has clearly shown intelligent characteristics. It can be predicted that in future wars, what is more important is the extension of "intelligence". Major changes will take place in the concept, form, style and method of operations. We must seize the development opportunities of artificial intelligence technology in the military field, seize the development opportunities of intelligent naval warfare, plan ahead and make fine layout, and strive to promote the intelligent development of naval warfare equipment.

References

[1] Ai X T, Wen X L, Yuan W B. Research on the future development of military intelligent software[J].Aircraft Design, 2021, 41 (4): 1-7.

[2] Ben K R, Yang L Q, Zhang Z X, et al. Application of military intelligence technology[M]. Beijing: Publishing House of Electronics Industry, 2021, 147-149.

[3] Qiu Z M, Luo R, Wang L, et al. Some thoughts on the application of military intelligence technology in naval warfare[J]. Air＆Space Defense, 2019, 2 (1): 1-5.

[4] Gui S H, Zou N Y, Li N. Development planning of artificial intelligence in foreign military field and application of ship intelligence technology in abroad[J]. Ship Science and Technology, 2020, 42 (7): 174-177.

[5] Yang J, Yang B H. Study of artificial intelligence technology development status in USA military domain[J]. *Aerospace Electronic Warfare*, 2020, 36 (1): 6-10.

[6] Ma Y L. Discussion on intelligent shipborne command and control technology based on public computing environment[J]. Ship Electronic Engineering, 2018, 38 (10): 28-33.

[7] Zhou L, Jin X W, Zheng Y K. Research on operational decision support based on deep reinforcement learning[J]. *Air＆Space Defense*, 2018, 1 (1): 31-35.

[8] Wang T, Zhu D Z, Yu X. Artificial intelligence aided decision making for anti-ship strike[J]. Computer Era, 2021 (4): 1-7.

[9] Qian G X, Sheng D. Thinking of the Application of Artificial Intelligence in naval gun firing[J]. Scientific and Technological Innovation, 2020 (16): 46-47.

[10] Liu S. Design of intelligence decision-making system for ships[J]. Computer Simulation, 2006, 23 (7): 7-10.

[11] Jin X. Inspiration to intelligent command and control from deep green and AlphaGo[J]. Journal of Command and Control, 2016, 2 (3): 202-207.

[12] Hu X F, Rong M. Where do operation decision support systems go: inspiration and thought on deep green plan[J]. Journal of Command and Control, 2016, 2 (1): 22-25.

[13] Wang L. Penetration and application of artificial intelligence into military field[J]. Science &

Technology, 2017, 35 (15): 15-19.
[14] Jin X. Status and development of intelligent command and control[J]. Command Information System and Technology, 2017, 8 (4): 10-18.
[15] Wang Y, Jiang Y, Li M Y, et al. Research and thinking on intelligence naval warfare[J]. Aerodynamic Missile Journal, 2020 (12): 11-16