Function Analysis of Command and Control System in Intelligent War

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Abstract—With the in-depth application of artificial intelligence and other new technologies in the military field, intelligent war has gradually emerged and shown a strong combat effectiveness. First of all, the main combat forces and functional modules of intelligent war are analyzed to grasp the characteristics of "autonomy" and "integration of cross domain operation and control" in intelligent war. Then the main functions of command and control system in intelligent war are analyzed and elaborated, focusing on the functions with human participation, the main contents of each function are stated in detail. Through the analysis of system functions, it can provide high reference value for the design and construction of intelligent command and control system in the future.

1. INTRODUCTION
After four historical stages, such as cold weapon war, hot weapon war, mechanized war and information war, the human war form is moving rapidly towards intelligent war. The battlefield has been developed from material and energy-oriented to information and intelligence as the main combat power generation factors. In today's information warfare, the production and application of intelligent weapons has brought about a significant increase in combat effectiveness, and with the continuous progress of intelligent weapons and intelligent warfare methods, intelligent warfare will inevitably show a strong fighting force that greatly exceeds information warfare, subversively changing the current mode of warfare and the form of war organization.

Intelligent war is a form of warfare based on artificial intelligence technology as force at the core in an integrated battlefield composed by land, sea, air, sky, cyberspace and cognitive fields, and it is based on the Internet of Things information system, the use of intelligent weapons and equipments and corresponding methods of warfare[1]. It is not easy for war to enter the intelligent era, as intelligent war is accompanied by the transformation of social and economic forms, artificial intelligence-based new technology development and the urgent need to compete for strategic commanding heights and rapidly develops. The Persian Gulf War in the 1990s marked the coming of the information war era, and the use of information-based weapons and equipments with intelligent factors and intelligent prototypes in the wars happened in Afghanistan and Libya, especially in Syria, produced a strong fighting force and powerful battlefield control ability, which foreshadowed the great power and superiority of intelligent warfare. Under the strong promotion of social and technical factors and the indisputable verification of war practice, the armed forces of all countries will take constructing an intelligent army as the future development direction, and strive to explore the law of intelligent war, study the rules of intelligent war design, and actively prepare to win intelligent war[2].
"If you don't abandon old ideas, you'll be abandoned by the future." Re-examining the command and control system from the perspective of intelligence, analyzing and studying the changes of the elements of command and control in the new military transformation, is the inevitable choice for our army to avoid the defeat of military struggle in the future intelligent war, and it is an urgent task apparently.

2. THE CHARACTERISTICS OF INTELLIGENT WAR
The formation of intelligent war is a long-term development process, benefited from big data, cloud computing, Internet of Things, nanotechnology, quantum information technology, biology and materials science and other directions of scientific and technological progress. With computing intelligence, cognitive intelligence, enhanced intelligence in the military field of extensive and in-depth applications, intelligent warfare will gradually become the mainstream form of war and trigger a profound military transformation.

2.1. The stages of intelligent war
Based on the influence degree of artificial intelligence and other technologies in war and the size of the effect of intelligent weapons in war, the development of intelligent war can be divided into three stages: the primary "point participation" stage, that is, a number of independent single-pack elements to a certain extent involved in a certain stage or combat action of the combat process; intermediate "module participation" stage, a number of associated intelligent equipments undertake a combat mission and participate in the combat process as a functional module; advanced "all-dimension autonomous cluster " stage, a variety of intelligent weapons flexibly organized corresponding to the task as a cluster, carry out the operations autonomously[3]. With the development of intelligent war from primary to advanced stage, the difference between intelligent system and information system is getting bigger and bigger, and gradually separates from the traditional information war mode and becomes a new form of war. As the core of command information system, command and control system is the brain of information warfare, which would change inevitably and profoundly on the intelligence process of war form.

2.2. The capacity of unmanned weapon systems
In information warfare, how to obtain the information control right, grasp more battlefield information, dispel the fog of war is the key to winning or losing a war; intelligent war is the battle for intelligence control right, whether it can quickly extract effective information in a large amount of data, efficiently make decision and act rapidly is the key to winning or losing a war. In order to obtain intellectual power, it is necessary to build a highly autonomous unmanned weapon system and a powerful intelligent auxiliary decision-making system. The intelligent and autonomous unmanned weapon system will gradually replace most of the tasks undertaken by the previous "human-machine" system and become the most basic combat unit in intelligent warfare. Various types of unmanned clusters with a high degree of autonomy, which can understand the battlefield situation, carry out distributed autonomous combat operations, achieve cluster autonomous coordination and inter-cluster autonomous cross-domain coordination, are the main combat forces of intelligent warfare, and men only appear in the battlefield when carrying out operations of occupation and control, as shown in Figure 1. In addition, commanders and operators have the ability to operate and monitor unmanned weapon systems to ensure the missions completed efficiently and accurately.

Unmanned weapon systems in the form of intelligent warfare will have the ability to perceive, cognize, analyze, plan, make decision and act, and will be able to automatically adjust and select combat weapons, combat formations, combat opportunity and mode of warfare according to different battlefield situations[4]. In unmanned weapons clusters, unmanned weapons platforms are capable to transmit and share information and instruction through various means of communication, and assign collaborative missions (e.g. reconnaissance, attack, search, surveillance, defense, etc.). Thus the situational awareness and operational effectiveness of unmanned weapons platforms are greatly enhanced. In addition, unmanned clusters in different domains can also share information and command through communication networks, and achieve multi-domain joint and integrated operations.
The action of unmanned cluster has the advantages over intelligence, speed, coordination and quantity, and with control of human or autonomy, it is able to apply all-round attack, distributed killing, swarm protection. Finally, the combat effectiveness is greatly promoted.

2.3. The main functions of intelligent war
The war form development to intelligent warfare will push the integrated joint operation from information fusion to platform fusion. In mission-driven mode, the generalization, standardization and integration of platform manipulation caused by intelligent unmanned system applications will gradually weaken and eliminate the boundaries between different services and arms. The key point of combat effectiveness generation is no longer the specialization of different military types previously, but through the autonomous integration of various types of unmanned weapons systems. And the efficient allocation of resources, optimizing operational options, seamless process and shortening "decision-action" cycle would be achieved consequently.

Unmanned systems with high autonomy and cluster intelligence can be operated simultaneously by one or more human operators during the mature phase of intelligent warfare. With regard to unmanned weapon operators and command and control systems, there is no distinction between military types, and various types of unmanned weapons systems would be flexibly and efficiently organized merely according to the different combat tasks. The combat form develops from the information integration in information warfare to the control integration of unmanned weapon system in intelligent warfare. Under the new form of combat and organization, the operational function of intelligent warfare consists of four parts: reconnaissance and intelligence, fire strike, command and control, and logistics services, as shown in Figure 2. In a certain combat system, the various operational forces divide the work and cooperate to complete combat tasks. All four functions are mainly implemented by various intelligent unmanned systems based on Internet of Things information systems, and men maintain the right to key decision-making control and a few other works which intelligent systems cannot accomplish efficiently.
3. Function analysis of command and control system

3.1. The comparison between information and intelligent system

In information war, command and control system is the information system in kinds of command post at different levels of the army. The function of the command and control system is mainly to help the commanders to carry out various operations in the command post, to assist the commanders to carry out command and control over troops and weapons, so that the commander not only can grasp the battlefield situation in a timely, comprehensive and accurate manner, but also have the ability to formulate scientific and correct combat plans, and to issue operational orders to the troops quickly and accurately[5]. Command and control system plays an important role in the commanders' control of the battlefield and grasping the pulse of war.

In intelligent war, intelligent unmanned system and sensor network can collect and process a large amount of battlefield information independently, efficiently and quickly, and transmit the extracted useful information to the command and control system; Because artificial intelligence and other technologies give unmanned weapon systems the ability of autonomous cognition, autonomous decision-making and autonomous action, many traditional combat tasks performed by human beings have been replaced by unmanned weapon systems[6]. In fact, with introduction of artificial intelligence, big data and other technologies and unmanned systems, battlefield intelligence reconnaissance acquires more abundant and comprehensive information, more efficient data processing, more rational and accurate decision-making, more compact combat process. Consequently the combat system is capable of better controlling the battlefield process, rapidly accessing to information and intellectual power, and ultimately win the war.

3.2. The main human functions of command and control system

From the composition structure, intelligent command and control system still contains information receiving and processing sub-system, combat command sub-system, combat support sub-system, technical support sub-system and system management sub-system. The functions of each sub-system can be achieved by intelligent modules. Men mainly do works which artificial intelligence cannot effectively handle or need to be controlled by human beings, and the human commanders retain the final decision-making power of major matters. Unmanned platform operators formulate operational rules for unmanned weapon systems, assign operational tasks, supervise the implementation, and intervene if necessary. And intelligent data processing modules can be manually processed by relevant personnel when some data cannot be effectively analyzed and identified. With the support of each sub-system, intelligent command and control system can provide services such as situation fusion sensing, operational planning, decision-making command, monitoring and evaluation. Apparently, the above analyses show that there are three main functions of intelligent command and control system which are done by people, such as unmanned platform command and control, decision planning and data processing. And the sub-functions and contents of each main function are shown in Table 1.

| Key functions | Sub-functions | Contents of the works |
|---------------|---------------|----------------------|
| Unmanned platform command and control | Action control | The combat process of unmanned weapon system is monitored in real time |
| | Weapon manipulation | Unmanned weapon system manipulated and controlled with long distance |
| Decision planning | Action decision | Military operations command decision-making |
| | Task planning | Priority setting of combat missions, rule setting of operational mission execution, process setting of operational mission execution, etc |
| Data processing | Information extraction | Big data analyzing and processing, intelligence information extraction |
| | Capability data generation | Data generation of unmanned platform performance, combat effectiveness |
In the course of intelligent combat, unmanned weapon platforms and unmanned combat clusters have strong autonomous tactical command and control capability, can collect and process intelligence effectively, and obtain intelligence advantage through distribution detection, synchronous perception and efficient processing. Besides, unmanned weapon platforms optimize decision-making, act quickly according to real-time battlefield situation, and finally obtain the speed advantage of intelligent decision-making and immediate response. Unmanned combat clusters can collaborate and share information between clusters, obtain the synergy advantage by self-editing group linkage, all-dimensional attack and defense, and gain the quantity advantage by flexible grouping, dynamic self-healing, distributed combat and saturation attack. Therefore, the intelligent command and control system with human interaction is mainly located in the high command post or war command center, grasps the overall situation of the battlefield and does a small number of important top-level works, which not only greatly reduces the burden of human in war, but also greatly improves the efficiency of command and control.

4. CONCLUSION
At present, the intelligent process of war form has just begun, but the application of new technology and new mode of warfare has gradually shown a strong fighting force, which has caused great impact on the existing war form. It is clear that the arrival of new military reform is inevitable. Because of the lag in technological development, mode of warfare and organizational form, there is still a long way to go before intelligent warfare maturity\[7,8\]. In the study of the operational form and winning mechanism of intelligent warfare, there is no real combat scene that is fully adapted to intelligent warfare for verification, and it is possible that future war situations cannot be accurately grasped now. In addition, with the development of technology, new modes of warfare and emerging combat forces may appear. Therefore, the functional analysis of intelligent command and control system will change with the development of technology, and finally the organizational structure and function settings that can maximize the effectiveness of intelligent combat force would be found, which provides an important basis for the construction of intelligent command and control system.

With the coming of intelligent war, the shackles of traditional combat thinking would be broken firstly, and a way of thinking that matches intelligent warfare should be established. Then the future combat form would be studied and analyzed with active attitude and positive action. With intelligent technical equipments vigorously developed, intelligent military personnel trained, intelligent training methods established, the army would be promoted to the intelligence transformation\[9\]. Finally, the army's intelligent combat capability could be developed in all aspects, and the goal of winning future wars will be achieved.

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