Research on Innovation of Urban Combat Equipment Support Model Based on Smart City and Artificial Intelligence

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Abstract. With the remarkable achievements of smart city construction and the evolution of war form to intelligence, the future urban operations will be intelligent operations supported by smart city. This paper analyses the requirements of artificial intelligence on urban operations equipment support, and clarifies the supporting condition provided by smart city construction on equipment support from the equipment status perception, equipment support command and control, equipment supply support and equipment maintenance support four aspects, focusing on winning urban operations under intelligent warfare. On this basis, a new support model of urban operations equipment support is proposed.

1. Introduction

According to the "Urban Operations" manual issued by the US military on December 7, 2017, there are more than 50% of the world’s population currently living in urban areas may increase to 70% by 2050, and urban operations are inevitable. Future military operations will be more concentrated in cities, and urban areas will become the main battlefield in the 21st century.

With the rapid development and widespread application of emerging technologies such as big data, artificial intelligence, and network information, the climax of smart city construction has set off worldwide. The application of artificial intelligence technology will not only have a significant impact on the construction of smart cities, but will also be a disruptive to the development of military intelligence and the transformation of warfare. The “National Defence of China in the New Era” published in 2019 pointed out that artificial intelligence, quantum information, big data, cloud computing, Internet of Things and other cutting-edge technologies are accelerating their application in the military field; the form of warfare is accelerating the evolution to informationized warfare and the beginning of intelligent war Appeared. It can be seen that the intelligent urban combat form under the condition of smart city will become a basic form of future urban operations. Under this condition, equipment support must adapt to the new battlefield environment and combat form, and take smart city as the support and intelligent support as the means to provide strong support for winning urban operations.
2. The requirements of intelligent operation to urban operations equipment support

Intelligent operation is a new form of combat spawned by the application of artificial intelligence technology in the field of warfare. What form of warfare should be matched what kind of equipment support mode. Equipment support as an important part of operational capability, must speed up to enter a new stage of intelligent construction, fully meet the challenges of the intelligent operations. Equipment support must change the current situation of poor timeliness, low reliability and poor performance of support benefits, and innovate the support mode to coordinate equipment support and combat operations with high-efficiency support as the requirement, precision support as the goal, and intelligent independent support as the means.

2.1. The situation of the battlefield in the intelligent urban combat is extremely complex, and the enemy and I are in a mixed state of attack and defence, which requires equipment support with fast, accurate and comprehensive state awareness

Knowing yourself and knowing each other is a prerequisite for making equipment support decisions. The urban battlefield has multiple complexities of geographical environment, humanistic environment, and information environment. Combat in a highly fragmented urban environment has the characteristics of limited scale and highly dispersed power. The two warring parties are often "There's me in you, there's you in me ", even encroaching on civilians. In the control of important targets, the enemy and I often encounter and cross together in a local limited space, making it difficult for the enemy to identify and the military and civilian to distinguish. At the same time, in the intelligent city operations, the equipment system faces a high risk of long-range, high-speed, accurate hard and soft damage.

In order to counter such threats as high-speed and accurate air and sky strikes, uav cluster attacks, special infiltration attacks, and sedition and destruction, the military and arms in intelligent urban operations are numerous, and social units and civilian forces are complex. Military and civilian forces are mixed and deployed in dense urban spaces, with complex equipment systems and different types of equipment. Equipment status awareness should be fast, accurate and comprehensive in the complex and complicated battlefield situation of attack and defense, military and civilian mixed through heavy fog of war.

2.2. The intelligent urban combat force is multiple and flexible reorganization, and the action is sudden and fierce, which requires the equipment support to have real-time, accurate and efficient command and control ability

The use of power in intelligent urban operations involves various military services and local forces. Various equipment support forces are not affiliated with each other, and it is difficult for them to communicate with each other, and have different support channels. As a result, the support coordination relation is complex and is difficult to form an organic whole. Through the formation of small, capable, efficient and sensitive combat units, the warring parties conduct dynamic restructuring, modular organization, and adaptive enhancement system to support the elite soldiers to achieve accurate release of operational effectiveness.

Not only puts forward high demands on operational collaboration, presents great challenges for equipment support command and control. With the application of stealth equipment and hypersonic precision strike weapons, the pace of intelligent operations is accelerating, and the intensity of confrontation is more intense. The extensive application of unmanned intelligent platforms such as unmanned aerial vehicles, unmanned vehicles, battlefield robots, and unmanned micro-platforms and so on also makes the concealment and suddenness of combat operations increase correspondingly, requiring higher timeliness of equipment support. Equipment support command and control must closely adapt to the adjustment of combat forces and the rhythm of combat operations, coordinate support forces in real time, and precisely control support operations.
2.3. The intelligent urban combat equipment is multi-dimensionally distributed, and many types for material demands, which requires equipment support to have fast, precise and three-dimensional resource supply capabilities

The battlefield of intelligent urban operations will cover multiple dimensions, including not only traditional tangible battlefield space such as land, sea, air and sky, but also the intangible battlefield such as cyberspace, electromagnetic space, and cognitive field. The targets that need to be taken and controlled are widely scattered inside and outside the urban area, including political and military targets, power, water conservancy, petrochemical and atomic energy facilities that are related to national economy and people’s livelihood, as well as potential targets such as military and civilian information hubs, manufacturing enterprises and scientific research institutions that affect the sustainable development of operational capabilities. The urban space is densely populated and built, and intertwined with roadways. The construction of underground facilities has developed rapidly, and the combat and support space is expanding to underground battlefields. Due to limited space, obstructed vision and restricted communications, the troops will conduct highly dispersed small group multiplex battles in various types of three-dimensional spaces within the city. While consuming a large amount of ammunition and other resources, intelligent urban operations will also cause a large loss of equipment, which inevitably requires a large number of types and quantities of equipment support materials. During the engagement, as the main targets of enemy attack, the support forces, resource targets and transportation system are easily subject to severe damage, which causes great pressure on the efficient collection, three-dimensional delivery, and precise distribution of equipment and materials.

2.4. The intelligent urban combat equipment has complex technology and diverse damage mechanisms, which requires equipment support to have quick and direct repair capabilities

The application of intelligent technology in the military field determines weapons and equipment toward unmanned, intelligent, and precise development, which indicates that the complexity and technical level of combat equipment will be raised to a higher, and the difficulty of equipment maintenance and support will also increase. In intelligent urban operations, personnel and equipment may be hit by all dimensions of land, sea, air, sky, electricity and nets. There are both hard destruction caused by conventional firepower attacks and soft killing caused by network electromagnetic attacks. So the mechanism of equipment damage is very complicated. In order to achieve system destruction and precision strike, various types of combat weapons also leap from precision to intelligence. The equipment use unit has limited self-healing capabilities, and the equipment technical support force is also insufficient in terms of strength scale, mobility, protection, and universality. It is difficult to provide close and direct accompanying support in the tense combat rhythm and the cramped battlespace.

3. The construction of smart city provide supportive conditions for equipment support

The concept of smart city is proposed in the context of the rapid development of new generation Internet, cloud computing and Internet of Things and other information technologies. Professor Yang Zhenghong defined it as “using the new generation of Internet of Things, cloud computing, big data analysis and other information technologies to integrate each core system of the city into a large platform and implant the concept of wisdom, to better understand and control city operations and optimize the use of urban resources. “The concept of smart cities proposed by the eight ministries and commissions such as the National Development and Reform Commission is: “Smart cities are the new intelligent concept and model to promote urban planning, construction, management and service, using new generation information technologies such as the Internet of Things, cloud computing, big data, spatial and geographic information integration and other information technology.” The application of smart cities are summarized in 4 aspects of municipal facilities, public services, social management and industrial development, and 14 specific applications are shown in figure 1.
Smart cities have the distinctive features of comprehensive perception, interconnection, technology integration, intelligent integration, and interactive collaboration. The realization of smart city depends on various advanced technologies as a support, including communication technology, network technology, cloud computing technology, Internet of Things technology, software engineering, GIS technology, building information model (BIM), information security technology, etc. With the support of many high-tech technologies, the supporting role of smart cities in urban operations is obvious. In urban operations, we can make full use of the construction achievements of smart cities, and give full play to the advantages of terrain, information, and technology to enhance overall operational level. As an important part of the combat system, equipment support must also catch the free ride of the smart city to provide accurate, real-time and efficient equipment support for operations.

3.1. The Internet of Things devices widely used in smart cities has promoted comprehensiveness of equipment support battlefield perception

In general, the Internet of Things is to "connect" everything and realize the interaction between people and things and things. With the gradual entry of 5G communication technology into commercial applications, smart cities will be fully covered by 5G networks, making "Internet of Everything" possible. Integrating 5G base stations into each equipment and even individual soldier platforms, each combat unit is a high-speed, large-bandwidth communication node. With the help of the Internet of Things technology and sensor technology, the status information of each equipment can be collected in real time, and the use of detection devices throughout the city, supplemented by military reconnaissance equipment such as uav, infrared detection and wall-penetrating radar, can be carried out the three-dimensional observation on local battlefield conditions so as to overcome the difficulties caused by the fragmentation of the battlefield space and the dispersion of personnel and equipment to the high-efficiency perception of equipment support due to the characteristics of dense constructions, three-dimensional interlaced roads and complex underground and overground projects in the urban environment. At the same time, through the use of optical fibre network and mobile communication network, the military communication network is connected to the municipal management platform, and the equipment support information can be efficiently transmitted to the equipment support command institution, which provides a basis for decision-making.
3.2. The smart management technology of smart city helps intelligence of equipment support command decision

In the urban management field of smart cities, advanced technologies such as big data, AR, AI, GIS, and BIM are widely used. The application of big data technology can effectively improve data processing ability and quickly obtain valuable information, which is of great benefit to equipment failure prediction, spare parts storage and management, etc. Through the application of GIS and BIM technology, we can use GIS technology to grasp the overall situation of the urban battlefield on a macro level, and quickly determine the key areas and important parts of equipment support, and microscopically, we can use BIM technology to make accurate analysis of each building and each enclosed space, which provide a basis for decision-making for accurate command of equipment support. The use of artificial intelligence technology can help to provide efficient and rapid decision-making in the fast-paced urban operations in the form of auxiliary decision-making. With the breakthroughs in virtual reality technology (VR), augmented reality technology (AR), artificial intelligence technology (AI) and brain control technology, equipment support command methods can be greatly enriched. The U.S. Army is currently studying urban combat robots based on gesture control, and their use in equipment support will have a disruptive effect on traditional equipment support command.

3.3. The intelligent traffic and intelligent logistics of smart city promote the intelligence of materials supply

In smart cities, new things such as intelligent traffic and intelligent logistics are widely used in advanced technologies such as big data, information identification technology, high-precision positioning technology and unmanned technology, creating unique basic conditions for equipment supply. According to the characteristics of high consumption resources and high scattered demand of urban combat, the use of big data technology can provide a scientific basis for the storage and turnover of equipment support materials, and improve the pertinence of material reserve to avoid waste of resources. The use of radio frequency tags, two-dimensional codes, bar codes and other technologies can solve the problem of equipment material classification. Combined with satellite positioning technology and Internet of Things technology, we can accurately locate the demands for a wide range of urban space equipment support that appear in streets, buildings and even underground, and implement full control and visibility of support materials. Compared to field conditions, various types of battles that take place in cities are sudden, small-scale, and short-lived. Equipment support must have a strong timeliness. The use of advanced delivery tools such as drones and unmanned vehicles, and in necessity the use the way of man-machine mixed marshalling and unmanned first approach, real-time and efficient delivery can be achieved under the conditions of effectively avoiding casualties.

3.4. The communication environment of smart city supports effectively remote in equipment rush repair

Smart cities have significant basic advantages in terms of traditional optical fiber, optical cable and other wired communication conditions. With the acceleration of the commercialization of 5G mobile communication, supplemented by communication means such as drones, satellites and portable base stations, it can effectively eliminate the large number of communication blind areas caused by the dense construction of urban area, complicated electromagnetic environment and the narrow and closed spaces in the underground and indoors, which has created favorable conditions for effective coordination between equipment support forces and support objects. It will become more rapid and efficient to take remote intelligent expert diagnosis system to guide the use unit to repair equipment based on advanced communication technology, and with the help of portable and embedded advanced communication terminals. In the future, on the battlefield of smart cities, there will be a large number of situations where combat forces repair themselves or repair under remote guidance.
4. Intelligent equipment support model for urban operations

4.1 The “active + passive” equipment status perception

It is a prerequisite for implementing efficient and accurate equipment support operations to realize comprehensive, accurate and detailed real-time perception of equipment status information. Equipment status perception in urban operations should not only focus on the construction of "active" perception capabilities that use new technologies to accurately predict the demands of various types of sensor data that are updated constantly and dynamically, but also pay attention to the improvement of the “passive” perception ability that aggregate information after the past equipment failures and materials shortage become established facts. The improvement of the active perception capability requires to drive the innovation of the perception method by technological innovation to realize the first perspective perception capability of comprehensive depth on the man-machine parallel battlefield situation. The improvement of the passive sensing ability should strengthen the battlefield environment construction based on strengthening technical ability of personnel, developing portable terminal of equipment support, standardizing data collection format and content and process. By constructing the networked data sharing platform, the organic integration of "active" and "passive" are promoted to provide strong support for intelligent prediction of equipment failures, optimization of support resource allocation and service of equipment support decisions.

4.2 The “Human Intelligence + machine Intelligence” equipment support command and control

The core of command and control is the “interaction” between people and people, things and things, and people and things. In order to adapt to the trend of intelligent weapons and non-intelligent weapons cooperating with the participation of people, we must innovate the model of the equipment command and control to realize the unmanned intelligence of equipment command and control. Through construction of the intelligent equipment command and control system with self-learning, self-adaptive and program comparison functions, it can automatically generate equipment support scheme and automatically distribute equipment support commands to achieve efficient equipment command and control. With the help of artificial intelligence technology, equipment command takes “human intelligence” as the core and “machine Intelligence” as the auxiliary, and reasonably conducts human-machine division and human-machine collaboration, and accelerates the development of multi-module information fusion technology, makes full use of distributed computing platforms, and enhances data fusion analytical capabilities to form an intelligent decision-making capability for human-machine integration.

4.3 The “Self-sufficiency + Order” equipment supply support

In order for the equipment system to continue to exert its operational effectiveness, we should adhere to the "self-sufficiency" supplement of combat power and the "order" supply of support forces to ensure the stability, continuity and accuracy of equipment supply support. We promote vigorously on-site manufacturing technology, using 3D and 4D printing equipment, and establish a self-sufficient equipment support model of battlefield on-demand production and raw material recycling and reduce military logistics burden and risks. The equipment status data collected by various sensors are analysed by using big data and cloud computing method. And equipment support needs are accurately predicted. So targeted combat reserve is conducted. With the force of the army as the main body, mobilizing the urban transportation department and logistics and storage enterprises as supplements, the urban transportation system is transformed according to military needs, and a military-ground integration equipment support storage and transportation logistics network is established, so as to place online orders as needed. And the real-time direct delivery service of all air, rail, roads and land routes can implement custom-made order distribution equipment support supply.

4.4 The "Front-end + Back-end" equipment maintenance support

In modern conditions of urban operations, the warfare usually occurs in a limited, fragmented battlefield space, often with limited scale and short duration, and battle damage equipment needs to be chosen or functionally repaired within a limited time. This has led to the fact that past companion
support cannot fully adapt to the requirements of timeliness, and must be supplemented by autonomous repairs and guided repairs in the background. The refined front end is to strengthen self-repair technology research and self-maintenance capacity construction. The strong background is to effectively generate intelligent prediction and remote diagnosis support capabilities. Give full play to the advantages of urban information resources and technical resources, integrate equipment support networks and smart city management platforms, and build equipment support remote expert diagnosis systems to realize automatic monitoring, automatic analysis and automatic summary of equipment status. Based on a large number of expert knowledge and equipment maintenance reasoning methods, an unmanned intelligent fault diagnosis system is developed to realize unmanned intelligent fault diagnosis of weapon equipment.

5. Conclusion

In the future, urban operations will be a joint operation of significant intelligence form and under the conditions of smart cities. Equipment support, as an important part of combat effectiveness, must pay close attention to the change of operational forms, and adapt to the needs of intelligent urban operations, and give full play to the technology and resources advantages and supporting role brought by construction of smart cities. The support model is innovated in terms of equipment status awareness, support command and control, equipment supply support and equipment maintenance support, and comprehensively improves the level of intelligent equipment support. Its structural relation diagram is shown in figure 2.

![Figure 2. Structure relation of new equipment support model](image)

And it provides a powerful support to win the urban operations in the new era.
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