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Research on the Construction of a Fifth-Dimensional Battlefield Based on UAVs – Integrated Electronic Warfare System to Seize Electronic Magnetic Rights

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Abstract. The electromagnetic battlefield is the fifth-dimensional invisible battlefield above the tangible geographical battlefield of land, sea, air and sky. The integrated electronic warfare system is a killer to seize the right to control the electromagnetic properties of the system to the system and the organization to organization in modern war. Unmanned aerial vehicle has significant advantages in terms of endurance, combat distance and mobility, which are more suitable for application in electronic warfare. In this paper, a method of constructing an integrated EW system based on UAVs is proposed, which takes integrated design, integrated control, integrated management and comprehensive application as the core. The single platform is realized through the hardware integrated of general sensors, general antennas, general interfaces and general processers, as well as software drivers of flight management, load management, navigation management and platform management. The multiplatform is realized through satellite platforms, high-altitudeand long-endurance UAVs, medium-altitude and long-endurance UAVs, medium -low altitude and long-endurance UAVs, vertical takeoff and landing UAVs, underwater UAVs, ground equipment and vehicle-mounted platforms. By means of combat classification commands, intelligence hierarchical processing and distributed confrontation to make each defense zone and each system can not only fight independently but also command cooperatively. The repeated use of force is reduced, the effective use of intelligence is improved, and the continuous combat force is ensured through the comprehensive management of three armed forces. Through the combination of peace and war, far and near, air and land, soft and hare, and true and false to maximize the effectiveness of integrated electronic warfare system most efficient. Therefore, the method in this paper will surely become a brand-new conceptual weapon with a high cost-effectiveness ratio and both attack and defense, which is of military significance.

Keywords. INEWS, UAV, electromagnetic dominance, fifth-dimensional battlefield.

1. Introduction

Electronic warfare(EW) is a military activity using the electromagnetic energy to weaken the enemy's electromagnetic spectrum activity and protect our own's, which includes

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electronic reconnaissance, electronic attack and electronic defense [1].Modern warfare is a system-to-system, organization-to-organization, battlefield-to-battlefield struggle. The integrated electronic warfare system (INEWS) is a killer to seize the right of controlling electromagnetic. Unmanned aerial vehicle (UAV) can play a great role in EW and the research of INEWS base on UAV proposed in this paper has great military significance.

2. Development of Electronic Warfare

2.1. History of Electronic Warfare

As shown in figure 1, the development of EW has gone through start-up, formation and development. During the sea war between Japan and Russia, the electromagnetic waves was used to combat support which mainly refers to the reconnaissance, decoding and analysis of radio communication [1]. From the first World War to the Second World War, the EW developed from single communication confrontation to navigation confrontation, warning radar confrontation and communication confrontation which impelled the electronic battlefield developing from naval warfare to air and land warfare [2]. During the Vietnam War, Vietnam seriously injured the U.S. Army with precision air defense weapons, which promoted the development of guided radar countermeasure equipment. During the Middle East War, there were many successful cases of using EW to carry out air defense [3]. During the Gulf War, the INEWS began to be fully applied, which was a milestone in the transition from mechanized war to information war. It was the first time for the US Army to apply C4ISR system in large-scale in the Kosovo war which rose EW from the campaign level to the strategic level [4-5].

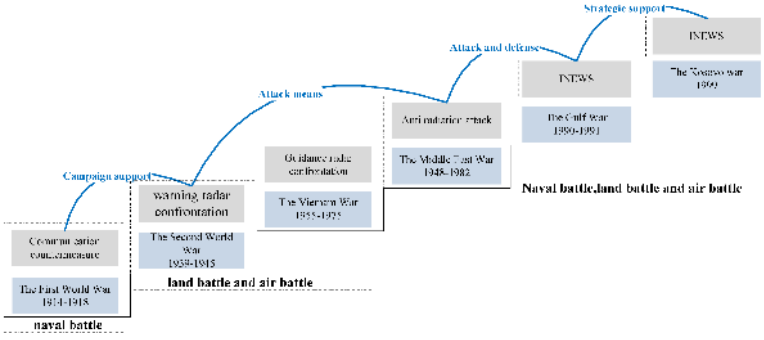

Figure 1. The history of electronic warfare.

2.2. Development of Electronic Warfare Aircraft

The Electronic warfare aircraft are becoming more and more increasingly improved with the continuous development of high technology. The EC-121 "constellation", which was put into use in 1953, is mainly used for air warning and electronic intelligence. The RC-135 "rivet" delivered in 1964 mainly undertakes the signal intelligence reconnaissance for tactical support. The EA-6B "wanderer" identified in 1966 can mount an AN/AQ-99 electronic pod and HARM high-speed anti-radiation bomb to interfere with the enemy's radar and communication system. The first flight of the F-4G "Wild weasel" in 1975 is

specifically used to detect and identify enemy ground -based anti-aircraft radar and surface-to-air missile positions, as well as to launch attacks with anti-radiation missiles;. The EC-130H "compass call" developed in 1982 is mainly used to jam attacks such as command and control systems and communication systems with the ability of network attack abilities. The EF-111A "Raven", which was commissioned in 1983, is an electronic jammer developed by General Dynamics and Grumman. The EP-3E "Aries II" delivered in 1991 is the only land-based intelligence reconnaissance aircraft of the United States Navy [5]. The Global Hawk Electronic countermeasure UAV, which played an important role in the Afghanistan war in 2001, is mainly used as an intelligence, operations with manned fighters [6]. The EA-18G "growler", which was put into service in 2008, is used to replace the EA-6B, which can not only monitor the target at full frequency, but also attack the time -sensitive target.

The advantages of UAV platforms are gradually emerging with the continuous improvement of the requirements on the operation time, combat radius and combat density in modern wars. An electronic warfare system based on UAVs will become a new concept weapon with high efficiency and the ability of attack and defend. In the meantime, INEWSs based on UAVs will cause a series of changes in military operational ideas, combat styles and operational organizations [7].

3. Design of the INEWS

It is difficult to guarantee the integrated performance against the enemies with single high-performance weapons or their simple sum of them in the modern wars. Only by integrated designing, controlling, managing and conducting design, control, management and implementation of the different equipment and methods can the INEWSs be built [8-9](As shown in figure 2). This is building an integrated system composed of land, sea, air and sky platforms for three military coordination to realize electronic reconnaissance, electronic defense and electronic attack, through which the electromagnetic dominance can be seized [10-12].

Integrated design is the basis for the realization of the integrated electronic warfare system, which is mainly divided into single platform integrated design and multi-platform integrated design. The single platform integrated design has developed from the hardware integration to hardware and software design. The multiplatform integrated design aims to multiply the electronic warfare force through the cooperation of multiple electronic warfare platforms and multiple operational means with the multiweapon killing power method.

Comprehensive control aims to control the system with operational-level commands, information hierarchical processing and distributed confrontation, which guarantees that every play and subsystem both has the ability to operate independently and adjust the configuration according to different requirements. If necessary, each subsystem can be organized into a larger unified command system to fit into a higher-level combat command network.

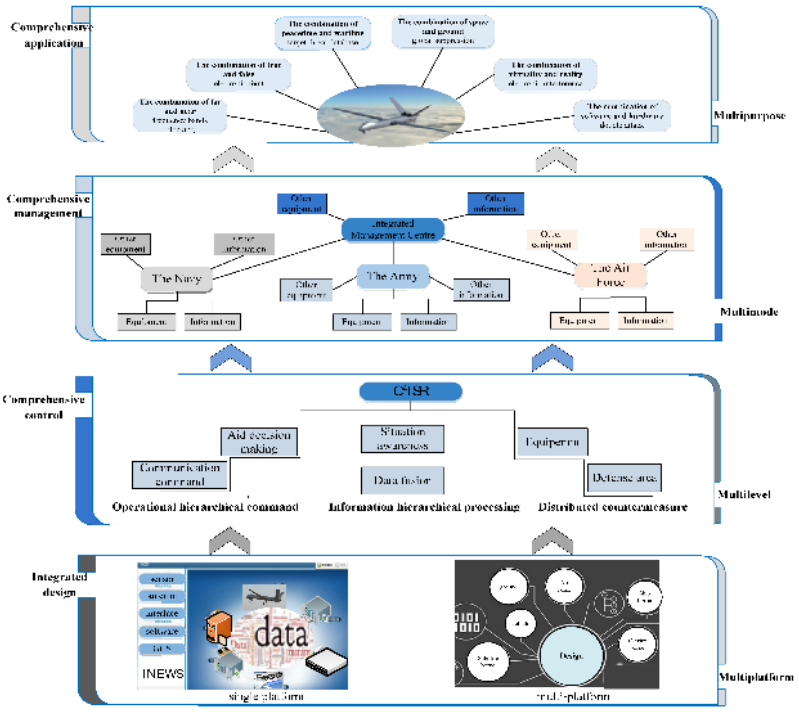

Figure 2. Design of INEWS based on UAVs.

Comprehensive management is an efficient way to guarantee that the armed forces complement and coordinate each other, which is also is the key to avoiding restriction and interference among them. Comprehensive management makes it possible to ensure that the combat forces continue by calling the armed forces flexibly, developing the forces' advantages fully, avoiding the repeated scheduling and improving the resource utilization according to the combat mission and process.

Comprehensive application is the catalyst to electronic warfare. This paper proposes a combination of peacetime- wartime, air and ground, far and near, software and hardware and virtuality and reality to realize threat library establishment, full frequency band locking, all domain suppression, double blowing, multiple means interference and electron trapping to maximize the effectiveness of electronic warfare.

Integrated design: The multiple weapon killing power method is realized through the single platform synthesis of onboard, airborne (high altitude UAV, medium altitude UAV, medium and low altitude UAV, vertical takeoff and landing UAV, underwater UAV, etc.), vehicle -borne and shipborne multi -platform cooperation, and hardware integration and software -driven single platform synthesis as shown in figure 2.

Comprehensive control: By means of operational hierarchical command, intelligence hierarchical processing and distributed confrontation, each defense area and subsystem can not only have the ability of independent operation, but also can carry out different configurations according to the requirements of different platforms of the three armed forces and the combat tasks of different defense areas. When it is necessary to form a higher -level command system, it can be integrated into a higher -level command system as shown in figure 2.

Comprehensive management: comprehensively manage the electronic warfare equipment and intelligence of the three services, ensure that all services can complement each other, do not restrict each other, coordinate with each other, and do not interfere with each other. According to the combat tasks and operational process, it can flexibly deploy the forces of each army, give full play to the advantages of each army, avoid the repeated use of forces, improve the efficiency of resource utilization, and ensure the continuous and reliable combat force as shown in figure 2.

Comprehensive application: Tactical application is the catalyst for the effectiveness of EW. Through the combination of peacetime and wartime, the combination of far and near, the combination of air and ground, the combination of software and hardware, the combination of presence and absence, and the combination of authenticity and falsehood, the establishment of threat database, full band locking, full range suppression, double strike, multi-means interference and electronic deception can maximize the effectiveness of EW system as shown in figure 2.

4. Integrated Design

4.1. The Design of a Single Platform

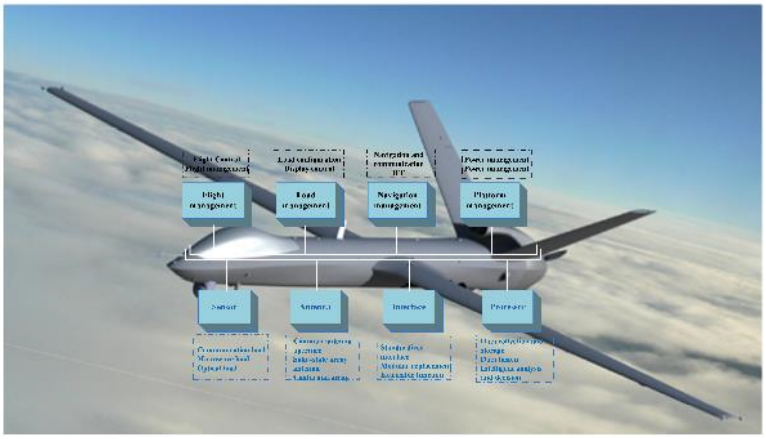

Figure 3. Design of a single platform integrated EW system.

As shown in figure 3, the design of a single platform integrated EW system mainly includes hardware integration and software drivers.

The purpose of hardware integration is to reduce the internal connection and subsystem duplication through complementary functions of sensors and resource sharing, so as to improve the reliability and maintainability of equipment and reduce electromagnetic radiation, which mainly includes general-purpose sensors, general antennas, universal interfaces and general-purpose processors. This paper makes designs CH-4 UAVs and CH-5 UAVs for microwave, communication and optical loads, which can realize the rapid transplantation between these two platforms. Through the common antenna aperture, conformal antenna array and other ways, the universal antenna is easier to complete ESM, ECM and other functions. All kinds of load interfaces are considered, and the standardized interface and module are designed that makes it possible to integrate loads within the platform. Sharing the processing hardware and

software and forming battlefield situation awareness provides guidance for intelligent analysis and decision-making.

The purpose of software drivers, which include flight management, load management, navigation management and platform management, is to realize system function reorganization through complex software. The standardized and modular design allows the system have the ability of reprogramming to reprogram on the spot, which can provide the best combination of platforms and loads according to the combat task and object, the optimal intelligent management of power and the appropriate communication, navigation and IFF management. Moreover, the software driver will automatically start the standby to make up for the failure module when a functional module fails, which surely forms a reliable adaptive system.

4.2. The Design of Multi-Platform

With the development of technology and the improvement of operational requirements, the EW system is transitioning from single platform integration to multiplatform integration. With the cooperation of multiple platforms, the common support of various databases, and the unified decision of the command center, the effectiveness of the integrated EW system based on multiple platforms is not only a simple superposition of the effectiveness of each weapon unit, but also times of an increase in the killing power of multiple weapons increase..

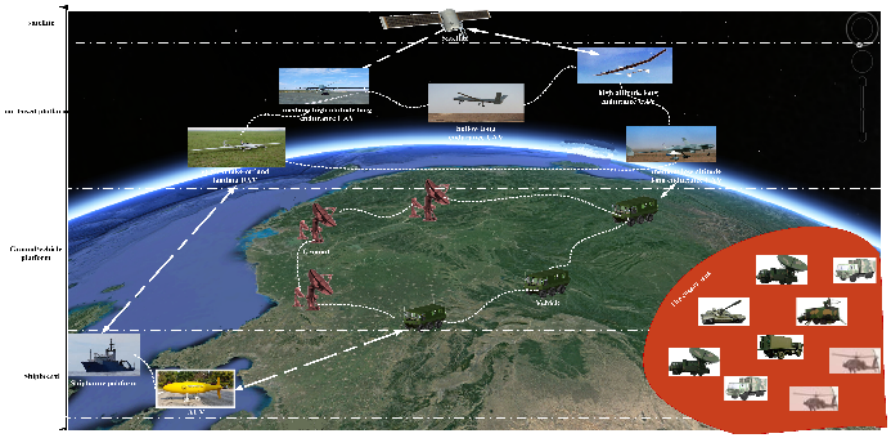

Figure 4. Design of multiplatform integrated EW system.

In this paper, a multiplatform integrated EW system as shown in figure 4 is proposed, and the space-based intelligence reconnaissance platform is constructed by satellite. The air-based platform coverage within 20000 m is realized by a high altitude long endurance UAV, medium high altitude long endurance UAV, hollow long endurance UAV, medium low altitude long endurance UAV and vertical take-off and landing UAV. The ground or vehicle platform is used to carry out tasks in front of the enemy's defense area, and sea-based mission coverage is achieved through ships and underwater UAVs. In addition, the vertical take-off and landing UAV can achieve shipboard take-off and landing, which further strengthens the interaction between platforms. The platform inherits the design concept of single platform standardization, generalization and miniaturization, while the platform adheres to the design concept of integration, serialization and extensibility, the

both of which ensure that the system can rapidly respond and technically update according to the task so as to maximize the combat effectiveness of the side. The system can even be reorganized according to the tactical changes if necessary.

4.3. Comprehensive Control

Operational hierarchical commands include establishing corresponding electronic command and control organizations at all levels, participating in operational plans, issuing operational orders and controlling combat units. Each level of combat unit can form an independent command and control system, and can form a larger command and control unit with the higher level until the top level.

Different information intercepted by multi multiple sensors is processed through information hierarchical processing to obtain the location, characteristics and battlefield panoramic situation map. Multisensor information fusion can not only reduce the ambiguity, and improve the credibility, but also make the intelligence more comprehensive and accurate.

A distributed countermeasure is achieved by the working mode, frequency band and combat object. Countermeasure control is carried out to ensure the redundancy and complementarity between the confrontation systems to realize that if one fails, there will be another supplement, so as to improve the reliability and survivability of the system.

4.4. Comprehensive Management

The Navy carries out EW mainly by means of shore based, shipboard and helicopter, the army mainly by means of ground, vehicle, UAV and helicopter and the air force mainly by means of ground, satellite and airborne. Obviously, it can be seen that the electronic warfare modes of the three armed forces have both similarities and characteristics. However, the traditional operation mode, which is relatively scattered and independent lacks close contact among the three services. In the face of the same task, the military forces are often used repeatedly and cannot be replenished in time after heavy damage. Therefore, coordinating the equipment strength and intelligence data of the three services is an effective way to realize the effective utilization of resources and rapid combat response, which is also the continuous guarantee of combat forces.

4.5. Comprehensive Application

According to the operational effectiveness evaluation statistics of modern EW, tactical application accounts for 50% - 60% of the operational effectiveness. Therefore, the comprehensive application of tactics is the finishing touch of the integrated electronic warfare system.

4.5.1. The Combination of Peacetime and Wartime.

The electromagnetic spectrum activity in the target area or in the sensitive area is accumulated in peacetime to form a target threat database, which is used for comparison with the information obtained in wartime. The electromagnetic target model, state, parameters and other information are all used to form a conclusion about the electromagnetic situation and threat level, and then to implement interference, the

enemy's combat effectiveness is heavily reduced in this way.

4.5.2. The Combination of Far and Near.

The main frequency bands of communication and radar are blocked by electronic warfare equipment of various types, large quantities and wide frequency ranges. The full blockade of the enemy's frequency band in wartime is realized by means of three-dimensional reconnaissance and various jamming.

4.5.3. The Combination of True and False.

Before the war, the use of transmitting frequency is strictly controlled, and the artificial false signals of analog electronic equipment are often set to create an electromagnetic environment. In the war, an electronic feint is implemented to lure the enemy into being deceived, and the real EW equipment is kept silent to improve the concealment. All the above is used for sudden artillery attacks if suitable and if necessary.

4.5.4. The Combination of Software and Hardware.

Electronic jamming, electronic deception and other soft killing methods are used to suppress enemy electronic equipment. Anti –radiation missiles and directional energy are used to destroy enemy electronic equipment. The limitation of electronic warfare equipment in suppressing time, power and distance is broken by the combination of software and hardware because of double attack, which is also of effectiveness to reduce the enemy's combat to the maximum extent.

4.5.5. The Combination of Virtuality and Reality.

When facing with different mission requirements, the passive jamming, which uses chaff to generate the false target echoes, or the active jamming, which uses the radar to transmit destructive signals, is chosen. Obviously, the effectiveness of the own interference is guaranteed in the way above.

4.5.6. The Combination of Space and Ground.

In this mode, UAVs usually carry out long-term. In this mode, UAVs usually carry out long-term and long-distance reconnaissance missions before the war. Ground/vehicle mounted equipment is set in a relatively safe area to give collaborative operational commands, including electronic jamming or electronic destruction to UAVs in the sensitive or dangerous areas in wartime, which is an effective way to protect the safety of fighters and a reliable way to realize the global suppression from land to air.

5. Conclusion and Prospect

The future electromagnetic battlefield environment is bound to be dense, complex and changeable. In the war of large depth three-dimensional, full band suppression, multi-means jamming and multi-level command, the integrated electronic warfare system

based on UAV can become a powerful shield in electronic warfare field with its flexible, safe and reliable performance. The construction of the fifth dimension Battlefield based on UAVs will be the necessity of the development of INEWSs. Moreover, the combination of INEWSs, C4ISR systems and main combat weapons will become a magic weapon to seize the initiative in modern combat systems.

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