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THE IMPROVEMENT OF THE UNMANNED AERIAL VEHICLES CONTROL IN THE CONDUCT OF MODERN WARS

The article presents some characteristic features of modern warfare. It is shown that the main task in conducting modern warfare is conquering and holding information superiority over enemy by using the possibilities of an integrated information and communication space by interspecific groups of troops, which is formed by various sources of information, including the widespread use of unmanned aerial vehicles of different purposes, as the main information sources that form this space. It is shown that in the future, the role of unmanned aerial vehicles will increase as one of the main elements of the air component of the intelligence, communication, navigation and striking systems, and will lead to their massive, synchronized and global application for the simultaneous solution of many problems in the interests of performing tasks by the interspecific troops group. This requires an urgent improvement of their control process. An analysis of the history of developed countries in the field of the unmanned aerial vehicles control was carried out. On the basis of which the appropriateness of improving the group control in their concentrated use in the course of modern warfare is determined and it should be made in three directions, using: centralized control of a group of unmanned aerial vehicles from a single control point; decentralized robotic control of a group of unmanned aerial vehicles; control with the leader as the most suitable for use in mixed groups of manned and unmanned aerial vehicles. Research results can be used in the development of advanced unmanned aerial vehicles or during their further modernization at the stage of reasoning of the tactical and technical requirements to them.

Keywords: *unmanned aerial vehicle, combat, troops, use, experience, direction, modern war, system, control.*

Introduction

Formulation of the problem. Wars (local conflicts) that were conducted and are conducting in the XXI century with the participation of the Armed Forces (AF) of many developed countries, and mainly the United States, are characterized by massive use of aerospace attack means, the transition of troop groups to non-contact military operations and the use of mobile, good armed interspecific army groups (IG), which solve various tasks for the elimination of a threat, and are significantly different from the armed struggle of the last century by their peculiarities as for the conduct of the common to all arms combat, namely: absence of a continuous front line between the troops; great dynamics of the changing situation, especially at the tactical level in the area of combat operations; expanding the tasks list that performed by different units of tactical level; a wide range of modern weapons and military equipment; use of a variety of information-analytical, intelligence and reconnaissance-striking systems and troops automated control systems and combat means; even more determined action of the troops, increase in their maneuverability, as well as a large spatial extent. Therefore, in order to manage its AF (contingents of troops, coalition troops) in the current conditions of US combat operations, they create and test a network-centric control system (NCCS), based on the use of the integrated information and communication space (IICS), which operates in real time and ensures the fulfillment of all tasks by the control bodies (CB) at all levels of control for the implementation of automated command and control of troops and combat means of IG AF when conducting various tasks and allows to solve the main task conducting the modern warfare as to conquering and maintaining the data superiority over the enemy.

The functioning of this system is aimed at creating global situational awareness for each element of the troops (forces) at the strategic, operational and tactical levels of control. The feature of this NCCS, which is being deployed for the management of modern and promising AF USA (in accordance with the Concept "One Prospect 2020"), is the use of the IICS that operates in real time by all its users in order to ensure the functioning of the three main components:

information-extraction (intelligence-information component);

information and control (component of collection, processing, evaluation, storage and distribution of data between users);

executive (component of military units, their personnel, military equipment, systems of lethal and non-lethal weapons).

The basis of the functioning of all three components is information (new methods for the formation, processing and issuance of data (real, graphic, video, intelligence information) to the leadership and CB of all levels of control, technical means (complexes, systems) in order to provide comprehensive support for the conduct of hostilities by modern multifunctional forces

formations in IICS, which will be based on the formation of a reconnaissance and combat information sphere (RCIS), where the main forming elements will be unmanned aerial vehicles (UAVs) of different function and other sources of intelligence information.

Therefore, the study of the issue of the improving the UAVs control when conducting modern warfare has a very actual value.

Analysis of recent research and publications. In the given references [1–14] the questions concerning the features of modern wars, the creation of modern forces, armaments and automated systems of military use, the use and control of the UAVs of different function are considered. But for the issues of improving of their control in modern wars, as the main elements of the air component of network-centric systems, the attention was almost not paid.

The aim of this work is to determine the further direction of the improving the control of UAVs in conducting modern wars.

The main material

The process of conducting the US AF network-centric operations in wars (local conflicts) of the XXI is characterized by the use of IG (coalition troops) in the IICS space, where the main element is information (primarily reconnaissance – data about the enemy (location of troops, objects of strike, air (ground-based, surface) targets), data on the dynamics of changes in the operational situation in the combat zone, and so on) and the processes of data exchange between users, with observance of all requirements concerning their authenticity, completeness, timeliness of obtaining, collection, protection and transmission. At present, many developed countries of the world are taking steps to implement the concept of forming a single information space in the conduct of hostilities. NATO implements the concept of "Network Enabled Capabilities", in France – "Information-centric warfare" (Guerre Infocentre), in Sweden – "Network Based Defense", in China – "Command, Control, Communications, Computers, Intelligence, Surveillance, Recognizance & Kill". The analysis of these concepts shows that all these programs track the availability of the intelligence system, because it is the main information base for the functioning of complexes of informational, calculation, analytical tasks and models, which are solved in various automated control systems of troops and means (ACS TM). The main elements of the intelligence system are reconnaissance satellites (RS), communication satellites (CS), aircraft of various functional purposes (including long-range radar detection and guidance (A LRRDG)), UAVs, ground complexes and intelligence, means of communication and data exchange (MCDE), appropriate control points and information centers and points (IC/IP), where processing of various information, including intelligence, is carried out.

The experience of the UAVs using in various conflicts by developed countries and the USA shows that the gradual improvements of their control were made, starting with the control of solitary UAVs (reconnaissance (R UAV), reconnaissance-striking (RS UAV), striking (S UAV), special purpose (UAV SP) – relays, monitoring of the globe) that performed specific tasks from the ground control points (CP) at the initial stage of their use, with a fairly simple control scheme, shown in Fig. 1, to their group use (Fig. 2), with the ability of controlling them from a variety of CP depending on the tasks they performed.

The single control of the UAV at the initial stage of their use, in the carrying out of their individual tasks was due to the transfer of the necessary commands on the radio communication channels (RCC) by the operator, who was on the ground CP to the UAV board to perform the necessary actions (as to the implementation of the appropriate maneuver or, for example, the switching on of the intelligence equipment, the use of destruction means).

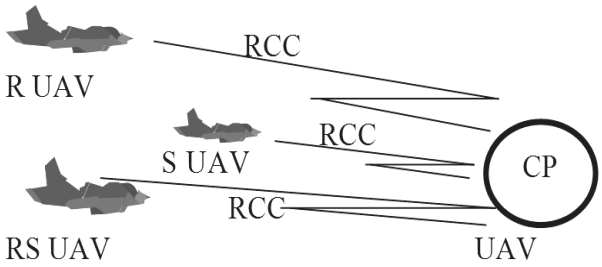

Fig. 1. Scheme of control of UAVs at the initial stage of their use

The intelligence information was sent to the ground CP in the opposite direction from UAV on the RCC (the results of the task completion for the S UAV or RS UAV) or the delivery of the appropriate intelligence equipment to this CP was carried out to decode the received data. The control in such a loop was not very reliable (the problem was to control the UAV at low altitudes and at considerable distances from ground-based air defense) and needed a very long time to process intelligence information and then transfer it to the information processing center (for its analysis, refinement and comparison with data derived from other sources of intelligence information). As the NATO UAVs had in their structure specific national equipment, software and communication facilities that, in their aggregate, did not allow them to receive information from them on other coalition troops CP, other than their own Armed Forces, this factor was a significant problem in the way of their control from the different CPs and the creation of a single coalition intelligence system, so the issuance of a local operational environment was carried

out with a significant delay on higher CP, both friendly AF and coalition forces, for its analysis and the formation of a combat tasks under proper combat means (artillery (A), rocket volley fire systems (RVFS), tactical aviation (TA), military aircraft (MA) and including UAV). Over time, this process has improved. The implementation of common standards as to the exchange, analysis, processing and presentation of intelligence information, their control procedures and flight safety in the use of UAVs in the airspace of the European continent, as well as the unification of specific technical equipment and software of the existing UAVs and those to be developed in the NATO countries were accomplished.

At the current stage of development of intelligence systems, MCDE and various automated control systems (for example, in the Combined Aircraft and Air Defense System (ADS) of the NATO countries (Air Command and Control System (ACCS)), that provide the planning and control of troops and means of aviation and air defense of the ADS of NATO member states in daily operations and in the course of hostilities, and also controls air traffic in the European part of the world, there is an opportunity to receive information from the aircraft LRRDG and R UAVs of the coalition forces to intelligence and airspace reconnaissance centers that enable processing of intelligence and operational data, the formation of a joint air, ground (maritime) situation from Norway to Turkey) and accomplish concurrent control of various information and intelligence sources of NATO member states.

Subsequently, in the course of modern combat operations of the US Armed Forces, it should be expected that the group control of the UAVs of different purposes simultaneously with different CP (air, ground, maritime) at all levels of control (tactical, operational and strategic) will be carried out, with a view to their global application in the airspace through the operation of the IICS, which will ensure the formation of intelligence information from various information sources, its processing, analysis on the appropriate IC (IP) and transfer of operational situation on account of the functioning of the centers (B) of a single telecommunication network (STCN) to all users, from the command (CB) of the respective levels of control of the IG in the area of combat operations, in real time, to the specific persons on the battlefield (soldier, crew) or means of defeat according to the control scheme shown in Fig. 2.

The gradual improvement of the control system of UAVs in the leading countries of the world allowed (due to the improvement of the MCDE, use of the latest information technologies in the processing, analysis and transmission of information, improvement of the UAVs control systems algorithms, in order to take into account the change of environment and develop appropriate management decisions for a corresponding change in the UAVs activities) to carry out the transfer of intelligence information in several directions, not only on its CP UAV but immediately through the CS, relay aircrafts (RA) to the ground centers of information processing (IC) or airborne CP (including the A LRRDG, UAVs group control aircrafts (GC A) (Fig. 2), which significantly increased the reliability of their control and the timeliness of receiving intelligence information, as well as shortened the time for the formation of combat tasks for the neutralization of targets that were detected in the process of conducting air reconnaissance.

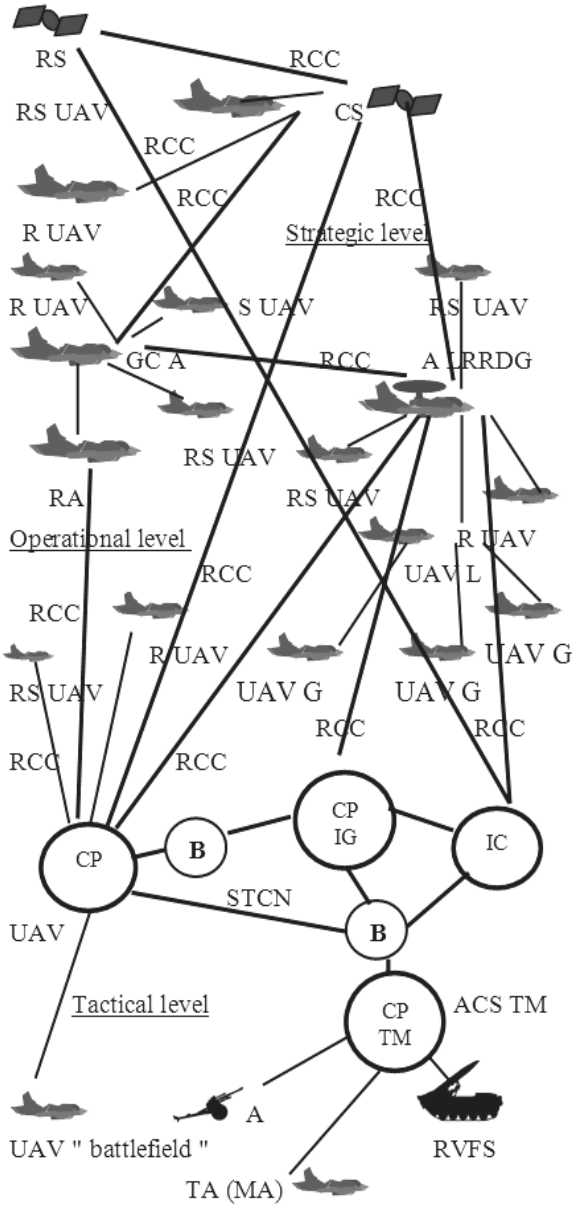

Fig. 2. The general network scheme of the UAV control in conducting modern combat operations

The integration of the UAVs with the ACS TM in the US Armed Forces, which is ensured by the use of network control of them in the conduct of modern combat operations, is carried out in two control loops: the

first – the external one, which determines the process of interaction of the CP of the corresponding ACS TM (CP IG) with the operator CP UAV and the second – internal, which determines the process of implementing the control of the UAV by the operator from the corresponding CP (air- based, ground- based, sea-based) on the tasks given in the automated mode from the command of the IG (CP IG). The process of external network control is carried out as follows.

On the basis of the developed plan of conducting an operation by the command of the IG (joint forces (coalition troops)), the task is arranged through the CP IG (CP ACS TM) to the corresponding CP UAV (A, carrying out the group control of the UAVs or the A LRRDG, which identify the air (ground, maritime) targets of the enemy and guide to them on the aircraft, including the UAV, within the limits of their responsibility, they will perform certain tasks in accordance with the determined plan on the conducting of hostilities (or carrying out the special operation)) in part of receiving an aerial reconnaissance request or destroying the targets. Next, measures of the second loop of the network control are carried out, in which the operator accomplishes: the definition of a particular payload for the UAV (UAVs group), plans the route for the task execution, evaluates the conditions in the area of the task execution and controls the UAV (UAVs group) in the performance of the task and evaluation of task execution. After that, the first loop continues to run. The received intelligence data and processed information from CP UAV are transmitted to CP IG (CP TM) to take it into account when setting the combat task to subordinate forces and firefighting means. The control point of the firefighting means (CP TM) on the basis of the received intelligence data or the specified operational situation from the IC (IP) performs the combat task using the firefighting means control subsystem to specific means (A, RVFS, MA, TA, S UAV, including UAVs of "battlefield") to destroy the forces and means of the enemy (Fig. 2). The control point of the fire-fighting equipment (PU VZ) on the basis of the received intelligence or the refined operational situation with the IP (IP) performs the combat task using the subsystem control of firefighting equipment by specific means (A, PCC, AA, TA, UBPLA, including FPLA "battlefield") to destroy the forces and means of the enemy (Fig. 2). After that, he carries out a report in an automated mode to the command of the IG through the centers of the STCN on the task accomplishment.

In some cases, when it is necessary to reduce the timing of the control cycles between the detection of the object and its elimination, especially in the course of a special operation (antiterrorist or the appearance of a especially important object) on the request of the CP IG, the CP UAV operator performs the reconnaissance of the indicated area with the recon-striking UAV and when the target is detected, the CP UAV operator gives permission to carry out an attack by the given UAV and it neutralizes the target. After that, a report is submitted to the CP IG on the completion of the task concerning the target destruction.

On the basis of the analysis of the development of the UAVs control when using by developed countries of the world, it is possible to state that in the future the role of unmanned aerial vehicles will increase as one of the main elements of the air component of the intelligence, communication, navigation and striking systems, and will lead to their massive, synchronized and global use, that needs at this time the improvement of their control process and, first of all, the improvement the network group control of the UAVs concurrently at all levels of control (strategic, operational, tactical). The advantage of the network group control of UAVs in comparison with other ways of controlling them (individually from the corresponding CP) shows itself in the following:

the decision of the planning task and controlling the actions of all UAVs can be done sequentially on the basis of the operation and synchronized in time when they are used (extensive, group or single) at all levels of control from any CP that controls it;

the secrecy of the information exchange on the radio links is rather high, since the distance between the UAVs in a group is relatively small, and the information from the operator on a certain CP is taken in the passive mode;

the high survivability of the UAVs group, as the functions of those UAVs that are out of order, in some group members, can be on-the-fly redistributed among other operable members of the group.

Therefore, the improvement of the process of the UAVs group control and their information support in the conduct of modern wars is a very topical problem, which, as the modeling of this process shows, it is reasonable to solve upon three directions:

centralized control of a group of UAVs from a single CP (for example, an A LRRDG or a special GC A or ground (sea) CP, Fig. 2), when all commands transmitted to the UAVs are formed on the corresponding CP, which allows for the integrated use of the UAV of different functional purposes, or the use of the so-called "swarm" – a large number of "battlefields" UAVs that will provide comprehensive implementation of the reconnaissance tasks of the relevant sector (area) of the conduct of hostilities, suppression of the radio-electronic means of the enemy (including the radar stations) and simultaneous destruction of its air defense firepower and other objects (targets) according to a single plan of the command or coalition troops command.

decentralized robotic control of the UAVs group, representing the process of independent control synthe-

sis on each element of the group, taking into account the general interests of the group control (a very difficult control process in implementation, because it requires the presence of high-speed and powerful computing devices, elements of artificial intelligence for the formation of an individual commands for each element inside the UAVs group taking into account changes in external and internal factors of influence on their tasks, as well as the compliance of the conditions of maximum achievement of the general objective which is set for the group);

control with leader is the most suitable for use in mixed groups of manned and unmanned aerial vehicles, where the role of a leader can be executed, for example, a manned aircraft (GC A, A LRRDS), which will control the group of UAVs of different purpose. With this control method a command of the control of individual objects (the leaders – UAV L) is formed on the corresponding CP, which control the subordinates of their UAVs group (Fig. 2).

The method of control with the leader gives the opportunity to move to the hierarchical control of individual elements – the leaders who control the leaders of a lower-level group, that is, the control of the whole group inside it from the leading element of the upper subgroup to the leading elements of the lower subgroups (UAV G) and so on.

For the future, the integrated, massive and synchronized use of UAVs should be expected not only to track the changes in the operational situation in the combat zone, but also to monitor the environment. One should also expect the full integration of the use of information derived from UAVs of different types and purposes over the whole area of combat operations in real time, due to its identification and analysis on the corresponding IC (IP) and its use by any user, whether it is the appropriate CB control points (both air and ground) or reconnaissance and sabotage groups at the rear of the enemy, or a separate commander of a combat vehicle, aircraft or soldier on the battlefield.

Therefore, now, it is extremely necessary to pay attention to the development of algorithms for control of large groups of UAVs ("swarm", "flock") with the optimization of collective interests. The general problem of group use of the attack and protection UAVs are high requirements for the performance of calculators, algorithms for calculating of trajectory control and their data support. Over time, a transition to the use of multi-agent systems, which in prospect will be the basis for the formation and functioning of the RCIS in the area of combat operations, should be expected. Because they allow agents (UAVs) to respond directly in the task area far from the CP IG or the information centre (A LRRDG), due to the use of hierarchical control, it greatly expands and increases the possibilities of the entire group of UAVs in performing their missions, in contrast to the control of the group of autonomous UAVs, operated by the operators personally from the corresponding CP.

Conclusions

Based on the research carried out as to the global trends in the control of the UAVs and, above all, the US, it may be noted that, first of all, it is necessary to improve the process of group control of UAVs in certain directions in order to achieve their concentrated, synchronized and global use in the airspace at all levels of control, as elements of the air component of the reconnaissance, communication, navigation, and striking systems. From a practical point of view, this material would be appropriate to use in the development of advanced unmanned aerial vehicles or during their modernization at the stage of reasoning of the tactical and technical requirements to them.

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ВДОСКОНАЛЕННЯ УПРАВЛІННЯ БЕЗПІЛОТНИМИ ЛІТАЛЬНИМИ АПАРАТАМИ ПРИ ВЕДЕННІ СУЧАСНИХ ВІЙН

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У статті наведені деякі характерні риси сучасних війн, показано, що головним завданням при веденні сучасних війн є завоювання і утримання інформаційної переваги над противником за рахунок використання можливостей інтегрованого інформаційно-комунікаційного простору міжвидовими угрупованнями військ, яке формується різними джерелами інформації і в тому числі, за рахунок широкомасштабного застосування безпілотних літальних апаратів різного призначення, як головних інформаційних джерел, що формують даний простір. Показано, що в перспективі роль безпілотних літальних апаратів буде збільшуватись, як одних з головних елементів повітряної компоненти систем розвідки, зв'язку, навігації та ударних систем і призведе до їх масованого, синхронізованого та глобального застосування для одночасного вирішення багатьох задач в інтересах виконання завдань міжвидовими угрупованнями військ, а це потребує невідкладного здійснення вдосконалення процесу управління ними. Проведено аналіз досвіту розвинутих країн світу щодо управління безпілотними літальними апаратами, на основі якого визначена доцільність вдосконалення групового управління ними при їх масованому застосуванні під час ведення сучасних війн, що необхідно проводити за трьома напрямками, застосовуючи: централізоване управління групою безпілотних літальних апаратів з єдиного пункту управління; децентралізоване робототехнічне управління групою безпілотних літальних апаратів; управління з лідером, як найбільш прийнятне для використання в змішаних групах пілотованих і безпілотних літальних апаратів. Результати досліджень можливо використовувати при розробці перспективних безпілотних літальних апаратів або при проведенні їх подальшої модернізації на етапі обґрунтування тактико-технічних вимог до них.

Ключові слова: *безпілотний літальний апарат, бій, війська, використання, досвід, напрямок, сучасна війна, система, управління.*

СОВЕРШЕНСТВОВАНИЕ УПРАВЛЕНИЯ БЕСПИЛОТНЫМИ ЛЕТАТЕЛЬНЫМИ АППАРАТАМИ ПРИ ВЕДЕНИИ СОВРЕМЕННЫХ ВОЙН

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В статье приведены некоторые черты современных войн, показано, что основным заданием при ведении современных войн есть завоевание и удержание информационного преимущества над противником за счет использования возможностей интегрированного информационно-коммуникационного пространства межвидовой группировкой войск, которое формируется разными источниками информации и в том числе, за счет широкомасштабного применения беспилотных летательных аппаратов различного назначения, как главных информационных источников формирующих данное пространство. Показано, что в перспективе роль беспилотных летательных аппаратов будет возрастать, как одних из главных элементов воздушной компоненты систем разведки, связи та ударных систем и приведет к их массовому, синхронизованному и глобальному применению для одновременного решения многих задач в интересах межвидовых группировок войск что требует совершенствования процесса управления ими. Проведен анализ опыта развитых государств мира по управлению беспилотными летательными аппаратами, на основе которого определено дальнейшее направление развития управления ими при применении их в современной войне, а именно: централизованное управление группой беспилотных летательных аппаратов с пункта управления децентрализованное робототехническое управление группой беспилотных летательных аппаратов; управление с лидером как наиболее приемлемый способ при использовании смешанных групп пилотируемых и беспилотных летательных аппаратов. Результаты исследований по дальнейшему направлению совершенствования управления беспилотными летательными аппаратами целесообразно использовать при разработке перспективных беспилотных летательных аппаратов или при их модернизации на этапе обоснования тактико-технических требований к ним.

Ключевые слова: *беспилотный летательный аппарат, бой, войска, использование, опыт, направление, современная война, система, управление.*