Scientific paper
004.89:623.746.2-519]:355.4

APPLICATION OF DETECTION RECONNAISSANCE TECHNOLOGIES USE BY DRONES IN COLLABORATION WITH C4IRS FOR MILITARY INTERESTED

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Abstract: *Information in the 21st century represents power, and thus the safest and most legitimate* "machine *for* domination". *The consequences of the rapid growth of information technologies and their usage for army purposes make information one of the key concepts of unconventional warfare. With the tendency for creating modern, better equipped and more effective armed forces, in all the armies of the world, there is an increasing need for gathering intelligence. As the precision and lethality of armed systems is increasing, so is the need for the rational and effective use of data. In this context there are technological and operational challenges to be met in terms ofprogress of the data collection and processing platforms, sensors, communication systems and their varieties. As one of the resources for collecting intelligence, the drones emerged with their different spectrum of use: significant amount of collected data in a short time period, in a large area and inside* opponent'*s territory, high accuracy and veracity of collected data, possibility for quick transfer of the focus of reconnaissance, i.e., a possibility for changing the object of reconnaissance during the reconnaissance mission. The purpose of this paper is to present a model of the system for command, control, communications, computers, intelligence, surveillance and reconnaissance – a C4ISR system with a focus on detection and reconnaissance by the use of drones in collaboration with C4ISR (supported by GIS) for military purposes.*

Key words: Drones, C4ISR, military, reconnaissance, GIS.

Introduction

Armies in the 21st century have to manage difficult operations in the field of unconventional warfare. Today, battles are won in the middle of large cities and on the computers in the operational center where information is the most powerful tool. Buildings and streets are the new battlefields, in which every corner hides different types of danger. Soldiers have very difficult tasks, to observe and save themselves from various attacks. There are objective

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needs for the implementation of drones, the use of which would provide adequate support to military units in conducting operations. It is possible to find a large number of drones on the market with different characteristics and different purposes.

Since their initial use for military purposes, drones have been adopted by governments and legal entities to provide a wide range of services, including traffic management, delivery of goods, inventory tracking, disaster management, wireless networks, etc. (Chamola et al, 2020; Liu et al, 2018; Zhao et al, 2019; Alladi et al, 2020a; Alladi et al, 2020b). A large number of armies of the world have different types of drones in their armament. The requirements of the army and the police for the characteristics of drones for use in different types of operations are very uneven. Drones have shown their importance and value in modern combat operations. The use of drones for military and civilian purposes is increasing.

The term drone has a broad meaning, it is a means with a motor that is remotely controlled by the operator or it is a means that has a certain level of autonomy (control is achieved using communication software, and often artificial intelligence is used together with different types of sensors), which can be used once or more and can carry deadly or non-lethal cargo and transmit data in real-time. It is a synthesis of the means and devices necessary to manage it. They differ in purpose, construction characteristics (shape, dimensions, weight, payload, maximum flight altitude, maximum range, flight time, speed, etc.), the environment in which they are used and the energy source that drives them. Depending on the purpose, they can be used in different environments such as land, water, air and space, and the broad spectrum of possibilities has enabled their use in defense and security (for the needs of the army and the police - original purpose), agriculture, construction, traffic, trade, communication, science, medicine, research, architecture, video and photography, geology, forestry, mining, oceanography, environmental management, sports, mapping, etc.

The focus of the paper is on the application of drones in the air. It is often found in literature that the term drone means all unmanned aerial vehicles (UAVs), regardless of whether they are remotely controlled by RPAS (Remotely Piloted Aerial System) or aircraft with a certain level of autonomy. The analysis of the content leads to the conclusion that the term air drone means the synthesis of an unmanned aerial vehicle and the device necessary to control it. (Milić et al, 2019) A broad spectrum of drone capabilities allows the use of drones for recording, monitoring, detection, tracking, (Radovanović et al, 2020) command, control, management, reconnaissance, etc., and these functions provide the possibility of using drones in the military units. There is a significant interest across the world in the development of drones that have the ability to fly in different environments and locations, perform realize different technical - technological missions. The type of drone is represented by UAVs - unmanned aerial vehicles that can fly over a space of several tens of meters to several thousand kilometres (Cavoukian, 2012), and are used for both military and civilian needs. The original use of drones for military purposes was for conducting observation missions, due to the possibility of displaying the image in real-time. Today, the use of drones is present in various activities.

The limitations of drones include limited autonomy of movement, battery life, limited payload, limited movement depending on the environment and physical obstacles (Hamurucu and Eren, 2020). The application of drone technology using drones along borders can reduce the cost of securing the border and reduce the involvement of people in border patrols (Mirzaeinia et al, 2020). Drones can reconnoitre and detect activities in areas with limited movement for humans and they achieve a significant advantage in cooperation with C4IRS systems (National Research Council, 2006; Figueira et al, 2020; Bihl and Talbert, 2020; Bommakanti, 2020). The greatest problem with the use of drones in reconnaissance and detection operations is the inability to communicate with them at greater distances. In order to solve this problem, two new principles are being developed (Milić et al, 2019):

– Communication with drones from fast-moving platforms;
– Communication with drones using drones as relay (mobile) stations.

Classification of drones

Drones differ in their characteristics depending on the platform and the purpose or practical use. (Krijnen and Dekker, 2014; U.S. Department of the Army, 2003) When classifying drones, it is necessary to thoroughly consider all aspects that can have an impact on different understandings of drones, in order to classify them as accurately and precisely as possible using methods of analysis, synthesis and classification. Today, there are several different divisions of drones depending on the institution that has classified them into different categories. Drones are most often classified in relation to the environment in which they are used, the purpose, the construction characteristics, in relation to the task, the source of energy that drives them and autonomy which is shown in Figure 1.

Figure 1. Drone classification factors

In relation to the environment, drones are divided into air, ground, water, underwater, space, as shown in Figure 2, where the complete classification of drones is outlined by the author. (Minoshma et al, 2019; Xiang et al, 2015).

Figure 2. Classification of drones

The European Association of Unmanned Vehicles (EUROUVS) has created a classification of drones based on the following characteristics: in terms of purpose, flight altitude, flight duration, speed, maximum payload (MTOW), aircraft dimensions, signal range, etc. (Arjomandi et al, 2006; Stevanović et al, 2019) In relation to flight altitude, takeoff weight, cargo weight, maximum range and maximum flight time, drones are divided into five categories as shown in Figure 3

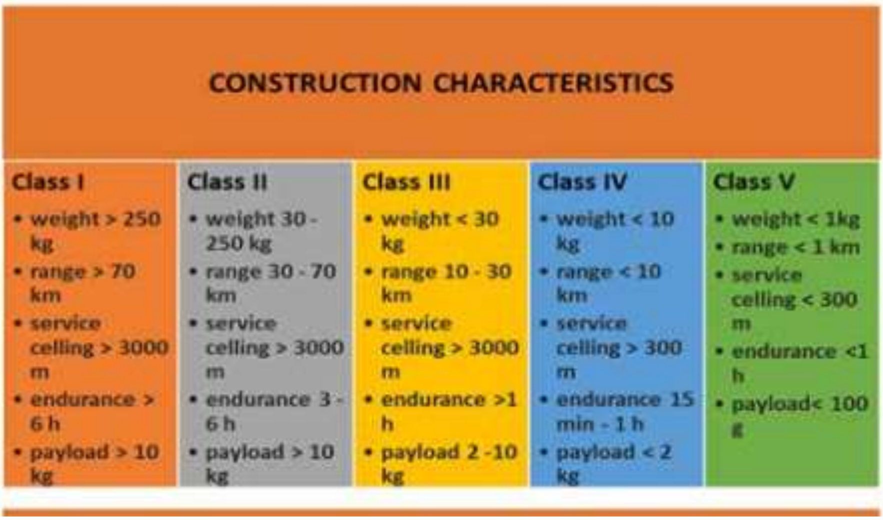

Figure 3. Drone classification

Based on the classification of drones, it is concluded that the characteristics of drones usually depend on their purpose. It is necessary to analyze the tactical and technical characteristics of drones in order to consider the possibility of their use in reconnaissance operations in cooperation with C4IRS.

Drones supported by C4IRS in geo -reconnaissance military operations

GIS is widely used in almost all branches of modern armies. GIS uses the following capabilities: command and control, defense mapping organizations, base operations and facility management, force protection and security, military engineering, mine clearance and mapping, mission planning, terrain analysis, etc.

The term reconnaissance means preliminary observation or research of a specific field for a mission to obtain information about the enemy or to locate it. Geo-reconnaissance determines the specific type of information gathered from the visual observation or other detection methods, which give us information about the terrain, geographical elements of it and objects in that specific area that can help us create a better picture of the enemy and the resources they are using.

C4IS is defined as a Command, Control, Communication, Computer and Informa- tion system. The Arc-GIS platform is an information technology infrastructure, and as such, provides a horizontal, crosscutting technology that is very different from other GIS technologies. One concept made a big step forward in the use of GIS for military purposes, especially military requirements. It is a NCO that represents a concept of Network-Centric Operations i.e. the use of a network to connect decision making across multiple defense domains and beyond. Therefore, NCO is much more than warfare. It connects warfare with strategic intelligence, and by that with installation management. This frame is way beyond the traditional defense and intelligence domain. Arc-GIS have a critical impact on each of the three concepts of NCO:

- Intelligence, Surveillance, Reconnaissance – ISR;
- Command, control, communications, computers and intelligence C4I;
- Precision engagement – PE.

The C4I domain supports timelier and better decisions by using a variety of tools to analyze, assess and plan actions. Arc-GIS bolsters C4I capabilities by providing a common spatial context and the tools to provide decision-makers, commanders and war fighters with a distributed and scalable environment for decision support.

The development of military technique management command systems seen in recent years has been made possible primarily by the development of microelectronics, the rapid decrease in size of IT tools, the enormous increase of their capacity and the integra- tion of their capabilities into a single system. This is applied by maneuvering robot aircraft, unmanned flying devices – drones and by all other armament management, deployment management systems, which are, on the one hand in interactive contact with the environ- ment, and guide interactively the given object, on the other.

Hence, one of the ways of data gathering is by aerial photographs and space images. The advantage of these kinds of data collection is the possibility for gaining information without getting any contact with the earth surface directly, but by contacting a mediatory unit carrying information about the surface. That kind of mediatory unit which carries assessment equipment to gain information is today's popular unmanned aerial vehicle (UAV), commonly known as a drone. With proper equipment, they can be used to observe and make live photographs of the enemy terrain. This method will reduce the number of people risking their lives for the purpose of collecting information.

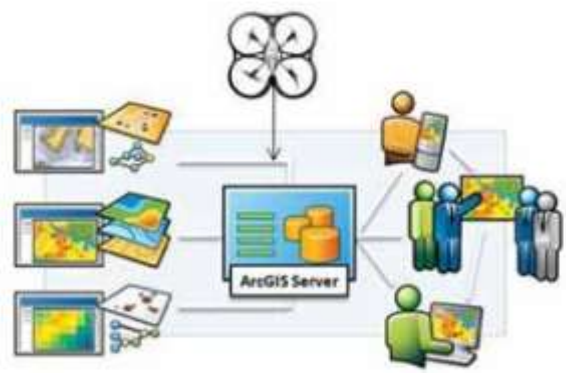

Figure 4: GIS Cloud mapping with drones

Developing a new concept and model of an information system that will include all these parts is the main idea of this paper. Creating an appropriate application for portable devices based on the model of the information system will facilitate the usage of these complex concepts. The Geo- reconnaissance and command (GRC) information systems are based on the GIS usage supported by drones for both Geo-reconnaissance and C4IR - Command, Control, Communication, Computer, Information and Recon- naissance. Thus, through the wide utilization of drones in collaboration with GIS, we want to create one completely defined information system which will help soldiers, commanders and strategic decision-makers to better observe their current situation, decide on their future actions, and, of course, provide after- mission feedback and analysis of the mistakes and give directions for further improvement.

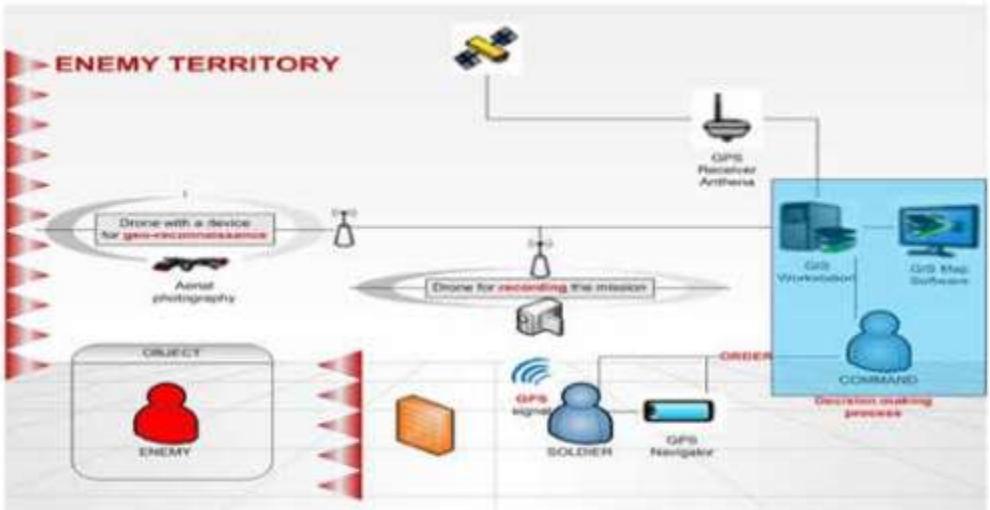

Figure 5: Model of Geo-reconnaissance and command (GRC) information system supported by drones and GIS

Based on our previous classification of drones in Figure 4, according to the characteristics of drones depending on their purpose and with a proper analysis of their tactical and technical characteristics in order to consider their possibility of use in reconnaissance operations in cooperation with C4IRS, we can make a multivariate use in a military operation.

Class one drones can be used for long-range reconnaissance operations supported with video live stream, multilayer Lidar data recording, thermal recording and weapons.

Class two drones can be used for middle-range reconnaissance supported by all previous systems, but with lower time capabilities.

Class three drones can be used for small range reconnaissance operations for live streaming, thermal recording without any possibility for weapon launching, because of the small weight capacity.

Class four and five drones can be used just for close distance operations for rescue operations with limited capacity for streaming and weight. In our model of Geo-reconnaissance and command (GRC) information system supported by drones and GIS in Figure 5 we use class four or in some specific operations, class five drones.

Drones – information system – geo-reconnaissance and command

The 1st step into creating this kind of complex system is equipping the direct participants i.e. soldiers with proper geo-locating equipment and that will be an emitter that will constantly send out signals. The receiving device, because sometimes the terrain is not accessible for all kinds of vehicles, will be set on the drone and it will forward the signals to the commander. The device set on this drone also will be in the role of an emitter, so it will send out various kinds of signals to the soldiers on the battlefield.

The 2nd step is receiving the information about the location of the unit and the soldiers in the commanding unit. In this unit, the commander with the help of the staff (headquarters) based on the locations of the soldiers shown on the monitor using GIS software (Arc-GIS and Geo-Rover), decides what actions will be taken. In this section, the functioning of the information system is mostly affected by the GIS usage for C4IRS, already described in the previous topic. Arc-GIS capabilities help in the decision-making process, giving to commanding unit various kinds of information, from a situational picture on the field to decisions made by other commanders, visualization of unit deployment, reports, and of course information received from the geo-reconnaissance.

Geo-reconnaissance actually is the parallel step to the geo-location step. GeoG reconnaissance, in fact, is the major element of this information system. With drones which is equipment with aerial photography, infrared sensors, lidar images, the command gets data and information about the situation on the enemy territory, about the enemy's soldiers, objects in the deep of the enemy line, fortification obstacles, and other information that can be beneficial later in the decision making process.

Geo-locating and Geo-reconnaissance give the input values in the information system. Then the human factor makes a decision, which represents the output from the system. This output can be in the form of directions about the movement, use of weapons, withdrawal, locations of IEDs. The orders are transferred to lower instances, and at the end, every soldier has a specific task to complete. If the "output" represents specific directions about the movement, that order is shown via GPS on the GPS navigator which is part of the equipment of every soldier.

An integrated part of the information system is the recording and live streaming section. A camera is set on the drone above the battlefield, so it records the real action. The video is transferred to the command, which can help make a better decision if the information is received from other sources (geo-reconnaissance, geo-location, radio devices). Additionally, the video material can be used later for mission analysis or battle. Drones are controlled by the command and their location and movement depend on the mission requirements.

Conclusion

Drones have a fast growth in today's world, but its capabilities have not been explored completely. The possibilities provided by drones supported by GIS have a wide range of use, and therefore this information system nowadays is being increasingly used in various fields of study. Of course, military industry discovers different ways of developing this information system by manufacturing new devices as drones, vehicles and weapons and also by integrating the GIS in the existing technologies.

A military information system based on connecting these two powerful usages of drones and information systems will help the armies in the world and decision makers to better observe the mission or battle and give accordingly specific orders based on the information collected from geo-reconnaissance and live-streaming of the situation on the battlefield. The data from geo-reconnaissance, i.e. the situation on the enemy's terrain and the geo-location of their own units and soldiers serve as input values for the commanders. The command makes a decision which represents an output value of the system, and it is sent out to the soldiers as a voice order or as movement navigation.

The greatest impact is that this system can be used in managing civilian crises, such as: earthquakes, floods, forest fires, road accidents, monitoring traffic in urban areas, first aid response with medical supplies, locating lost persons in the mountains, after earthquake search missions with thermal camera drones, search operations on inaccessible terrain, etc.

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