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Characteristic Analysis and Development Direction for Defense UAVs

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Abstract

What we have in common worldwide today is economic difficulties due to high inflation and uncertainty in the financial industry. The root cause of this is the war between Russia and Ukraine. The war between Russia and Ukraine is not simply a war between two countries. The United States and the European Union are providing military aid such as missiles to Ukraine, and Russia is attacking Ukraine by introducing UAVs (unmanned aerial vehicles) from Iran. A prominent weapon in this Russia-Ukraine war is the UAVs used in Russia. It is predicted that the form of war using UAVs will gradually expand in the future based on stealth. In addition, UAVs will continue to be used due to the fact that they can cause serious damage to the other country without harming their own lives, and because they have good cost-effectiveness. In this study, UAVs based on autonomous driving were studied. The target countries of the study include the United States, the European Union, China, and Iran, and the UAVs used in these countries have characteristics that can represent the world. In this study, the main specifications of major UAVs in use in major countries were investigated. In addition, the future technology and development direction were described through specifications and characteristics of UAVs currently in operation in major countries.

Keywords: *UAVs, Russia-Ukraine war, Autonomous, ICT.*

1. Introduction

One of the characteristics of the war between Russia and Ukraine is the use of unmanned aerial vehicles (UAVs). An unmanned aerial system known as a drone is a general term for military UAVs capable of flying and controlling by induction of radio waves without a pilot [1-3]. UAVs are remote piloted from the ground without a pilot directly boarding the aircraft, autonomous flight in the form of auto-piloted or semi-auto-piloted according to a pre-programmed route, or equipped with artificial intelligence functions. Therefore, it judges the environment on its own and performs its duties.

In this study, UAVs used for military purposes were described. The role of military UAVs is rapidly increasing [3-10]. The background of the rapid increase in the use of UAVs is the convenience of information collection and the ease of deploying lethal force. There were 74 US drone strikes in Afghanistan in 2007, and five drone strikes in Pakistan in the same year. By 2012, US forces had carried out 33 drone strikes per month

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in Afghanistan, exceeding 330 to date in Pakistan [11]. Currently, the domestic UAV industry seems to have a weaker will for R&D compared to competing countries, but the military UAV market is expected to increase from about 42 units in 2016 to 116 units in 2025 [1]. In this study, we described the current market, research trends, and future research directions for unmanned aerial vehicles related to national defense.

2. Comparison of Major UAV Specifications

2.1 Key Specifications of U.S. UAVs

The history of UAVs in the United States has a long history of UAV development, starting with the UAV called the Catering Bug in 1918. The United States continues to invest in unmanned aerial vehicle technology development and research every year to gain a technological edge. Since the Vietnam War in 1950, the United States has used military drones for reconnaissance purposes on a limited basis. However, it was after the September 11, 2001 terrorist attack that drones began to be used on the battlefield in earnest. From this point on, the United States began to actively utilize military drones as one of its counter-terrorism strategies. Currently, state-of-the-art military UAVs such as the Global Hawk and Predator are being used. These UAVs are largely classified for reconnaissance or attack, and are being developed or actually used. The Global Hawk has the ability to identify objects up to 0.3m on the ground using radar and advanced detection equipment at an altitude of 14.000m. It has excellent reconnaissance capabilities and a wide operating radius, and has the nickname of a ground-based artificial satellite. In addition, the Global Hawk is a representative example of an existing high-altitude reconnaissance UAV, and its utility has been proven and used. For this reason, it is used worldwide in the United States, Germany, and Japan, and Korea was also scheduled to introduce four units in 2018, but it was delayed until early 2020 and was recently introduced [9].

The representative military Predator was first used in the Kosovo crisis in 1995, and since then it has been active mainly in Iraq, Pakistan, and Afghanistan. The Predator, which was used for reconnaissance in Kosovo and the Middle East, was upgraded in 2001 for attack with missiles with US Congressional approval. The improved model is considered a representative example of an attack drone, with a record of bombing and killing bin Laden's closest associates, including al Qaeda officials. At the time, the Predator's long-distance reconnaissance and precision strike capabilities played a role in informing countries around the world of the role and power of military UAVs on the battlefield. Currently, a new improved model, the MQ-9 Reaper, with significantly increased operational range and weapon loading capacity, has appeared and was retired in 2018 [13]. As such, the United States invests the largest budget in the world to develop and operate various military UAVs. As the world's largest investor, Korea operates the largest number of military drones as a single country. The development of military UAVs in the US is progressing widely, from large high-performance UAVs such as the Global Hawk described above to micro-reconnaissance UAVs. In addition, NASA's MQ-9 Reaper, which was developed for civilian research purposes in the recent RIMPAC exercise, succeeded in taking off and landing on an aircraft carrier, showing that the era of using unmanned aerial vehicles in maritime operations has opened. The specifications and characteristics of representative UAVs in the United States are shown in Table 1 below.

Table 1. Major specifications of US UAVs

	Global Hawk	Predator	Reaper
Purpose	Reconnaissance	Reconnaissance, Attack	Attack
Length (m)	14.5	8.22	11
Speed (km/h)	629	222	482

Range(km)	22,800	1,250	1,900
Carrying capacity(kg)	1,360	204	1,700
Maximum altitude (m)	20,000	7,620	15,000

2.2 Key Specifications of EU UAVs

Military drone development in Europe started relatively late compared to the United States. Therefore, it did not have its own manufacturing technology, so it was enough to introduce and use drones from the United States and Israel. However, Europe is now also recognizing the importance of military UAV's influence and technology, and is concentrating its investment on development. Europe, which has a long tradition of aviation technology, is rapidly developing military UAV technology and narrowing the gap.

The development of military drones in Europe is taking the form of collaboration in which several countries join forces. First of all, Europe's representative UAV, nEUROn, is a stealth drone developed by European companies such as Dassault Aviation of France, and has been tested for two years since its first flight in 2012 [2]. The neuron was 9.5m long and 12.5m wide, and the engine was Adour produced by Rolls-Royce Turbomecca, a joint venture between Rolls-Royce and Turbomecca in the UK. Applying various technologies such as aerodynamics, stealth technology, and automation, this UAV avoids detection with its stealth function when threatened on the ground or in the air. At the same time, this drone is targeting reconnaissance work through autonomous flight and even the role of an attack aircraft that detects ground targets and uses weapons mounted in the aircraft. The vertical tail fins were also removed to avoid being easily spotted by enemies.

UAVs equipped with these technologies and strategic goals are expected to be much closer to manned aircraft than existing UAVs. Meanwhile, Neuron aims to be introduced into European air forces by 2030. Half of the development cost of 406 million euros is borne by France, and companies from Sweden, Italy, Spain, Switzerland and Greece are participating in the project. Military drones under development in Europe include the Neuron and the Barracuda jointly developed by Germany and Spain. Their main specifications are shown in Table 2 below [2].

Table 2. Major specifications of EU UAVs

	nEUROn	Barracuda
Purpose	Attack	Reconnaissance, Attack
Length (m)	9.5	8.25
Speed (km)	980	647
Range(km)	-	200
Maximum altitude (m)	14,000	6,000

2.3 Key Specifications of China UAVs

China first started manufacturing military drones in 1959, and has been maintaining mass production since the 1980s. Military UAV technology is still behind other frontrunners such as the US, Israel, and Europe, but civilian UAVs occupy 70% of the world market. Based on the growth of civilian UAVs, military UAVs are also terrifyingly pursuing under the full support of the state. As if to disprove this, the number of unmanned aerial vehicle development manufacturers in China is rapidly increasing every year. About 75 to 100 companies are known to specialize in manufacturing military drones.

The drone compared to the US Global Hawk is the Xiang Long. Xiang Long made its first test flight in January 2013. Developed as a high-altitude long-endurance UAV, Xiang Long is known to have an operating altitude of 17,000m and a range of up to 7,500km. It is possible to fly for 10 hours in one sortie, and it has

been shown that it has the capability to scout not only Korea and Japan, but also the American territory of Guam. Based on the steady development of military UAVs, China most recently unveiled the CH (ChaiHong)-5. The CH-5 is said to have been developed to counter the MQ-9 Reaper, an American reconnaissance and attack drone. The Caihong-5, developed by China's state-owned company China Air and Air Group Corporation, can carry up to 24 missiles in one sortie and operate continuously for 48 hours. In particular, it is known that a wall penetrating radar capable of identifying and tracking targets within a building can be mounted. The approximate specifications of China's main attack drones are shown in Table 3 below [2, 13].

Table 3. Major specifications of China UAVs

	WZ-7(Xiang Long)	Wing Koong 1(YiLong)	CH-5
Purpose	Reconnaissance	Attack	Attack
Length (m)	14.33	9.05	11
Speed (km)	800	280	300
Range(km)	7,000	4,000	2,000
Maximum altitude (m)	17,000 ~ 18,000	5,000	9,000

2.4 Key Specifications of Iran UAVs

Iran's UAVs have been in the spotlight since the recent war between Russia and Ukraine. Many media outlets around the world are reporting that Iranian drones are being used by Russia. These drones are playing the role of unmanned bombers in Russia's war with Ukraine. Shahed-136 are representative unmanned attack aircraft of Iran. The approximate specifications of Shahed-136 are shown in Table 4 below [2, 14]. The Shahed model is a model developed by Iran Aircraft Manufacturing Industry Corporation in 2021, and is known to have a flight distance of 2500 km, a maximum speed of 185 km, and a weight of 200 kg.

Table 4. Major specifications of Iran UAVs

	Shahed-129A	Shahed-136	Shahed-149
Purpose	Attack	Attack	Attack
Length (m)	8	3.5	10.5
Speed(km/h)	150	185	350
Range(km)	1,700	1,000~2,500	7,000

Shahed-136 is known to fly all over Ukraine with a maximum flight distance of 2,500 km, although its speed is rather slow at 185 km/h. It has the advantage of being able to fly at relatively low altitudes. On the other hand, it has the disadvantage that it can detect an attack from several kilometers due to its large noise and that it is slow.

3. Comparison of Main Characteristics of UAVs and Development Direction

3.1 Comparison of Main Characteristics

In Chapter 2, we examined the main specifications of UAVs in use in major countries. The United States has an edge over other countries in key technologies needed for drones. Technology such as maximum altitude, operation radius, speed, stealth function, and artificial intelligence required for air defense and reconnaissance, which can determine victory or defeat in war, was concentrated. On the other hand, the European Union's unmanned aerial vehicles are following the advanced technology of the United States. China is also accelerating the development of military UAVs based on its superiority in the commercial UAV market. So

far, it seems to show lower performance than the United States in terms of maximum altitude, stealth function, and application of artificial intelligence. Iran's drones seem to be somewhat different from those of developed countries in terms of technology. It has disadvantages such as slow speed and high flight noise. The main characteristics of these UAVs in each country are shown in the table 5 below.

Table 5. Main characteristics

USA	Advantages	• Minimize UAV Size, High speed, Maximum altitude • The most advanced technology for evading enemy radar networks for reconnaissance UAVs • UAV armoring technology
	Disadvantages	• High price
	Direction	• Enhanced UAV intelligence, stealth, and armored
EU	Advantages	• High technology in aviation industry • Minimize UAV size
	Disadvantages	• Relative lack of UAV altitude and speed-related technologies
	Direction	• Intelligent UAV, enhanced stealth • Collaboration system among EU countries
China	Advantages	• Drone speed • Wide commercial market other than military use • Accelerating UAV industry and related technologies
	Disadvantages	• Relatively poor technical skills in the field of maximum altitude and advanced technology • Relatively inadequate technology in material parts, which is the original technology of UAVs
	Direction	• Intelligent UAV enhancement, stealth enhancement, maximum altitude
Iran	Advantages	• Good value for money
	Disadvantages	• Large noise and low altitude, slow speed.
	Direction	• Reducing the noise of drones, Increased drone size and speed

3.2 Comparison of Main Development Direction

The major UAV developing countries reviewed so far are still investing a lot of development costs in R&D in order to dominate the global market based on their technological prowess. The United States, which has a technological advantage, is expected to focus on protecting advanced technologies through export restrictions on core technologies, and this trend is expected to further strengthen. It is expected that China will maintain the advantages of commercial UAVs and continue efforts to narrow the technological gap in military UAVs. Europe, which has recently been dominant in the civil aviation industry, is rapidly developing in the form of a consortium through cooperation between countries, and this form will continue. A brief comparison of future policies and development directions related to UAVs in major countries is shown in Table 6 below.

Table 6. UAV policy and development directions comparison of major countries

Nation	Main characteristics
USA	• Strengthen dominance in military drone market based on excellent technology • Government-led research and development • Strengthen efforts to protect core technologies through export regulations

EU	• Expansion of continuous technology development for UAVs based on aviation industry technology • Research and development in the form of a consortium by European Union countries • Continuous R&D for the advancement of UAVs due to the Russia-Ukraine War
China	• Efforts to bridge the technological gap between military UAVs by using the advantages of commercial drones • Easy market entry using superior cost-effectiveness compared to US drones • Advancement for UAVs
Iran	• Continuous efforts to improve the shortcomings of domestic UAVs

4. Conclusion

With the recent outbreak of the Russian-Ukrainian war, the industry that is drawing attention to us will be the military drone industry. Also, North Korea's unmanned aerial vehicles are showing a lot of interest to us as they fly over Seoul. Taking this as an opportunity, this study investigated the main specifications of the UAVs of major UAV developing countries, and based on this, the advantages and disadvantages of each country were described. In addition, major policies and development directions for unmanned aerial vehicle development were identified. The United States, which has a technological advantage, will focus on protecting advanced technologies through export controls on core technologies. China will maintain the strengths of commercial UAVs and continue efforts to bridge the technological gap in military UAVs. Europe, which has an edge in the civil aviation industry, is rapidly developing in the form of a consortium through cooperation between countries, and this form will continue. Iran, which is mentioned in the Russia-Ukraine war, will continue to promote efforts to solve the shortcomings of its own drones. Despite notices of market changes by various organizations, the United States remains the leader in the military drone market, but competition will intensify as other countries enter the drone market. The focus of technological competition among major countries will be concentrated on a wide operational radius, stealth and light weight, and enhanced loading capacity.

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