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AN IT REVOLUTION: ARE UCAVS THE FUTURE OF AIR COMBAT?

Annotation: The paper suggests information technology driven UCAVs as a possible solution in countering conventional defense aviation threats in a technically competent and cost effective manner. The article suggests that information technology, artificial intelligence and the application of both can revolutionize the industry and bring a paradigmatic shift. The argument is in favor of UCAVs to supplement 4th generation fighters and as a competitor to generational thinking itself.

Key words: Information technology, unmanned vehicles, UAVs, UCAVs, defense, aerospace, artificial intelligence

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ИТ-РЕВОЛЮЦИЯ: UCAV - ЭТО БУДУЩЕЕ ВОЗДУШНОГО БОЯ?

Аннотация: В документе предлагается использование UCAV на основе информационных технологий в качестве возможного решения для противодействия угрозам обычной военной авиации технически компетентным и экономически эффективным образом. В статье предполагается, что информационные технологии, искусственный интеллект и их применение могут революционизировать отрасль и принести парадигматический сдвиг. Аргумент в пользу UCAV дополняет истребителей 4-го поколения и является конкурентом самому мышлению поколений.

Ключевые слова: информационные технологии, беспилотные летательные аппараты, беспилотники, UCAV, оборона, авиакосмическая промышленность, искусственный интеллект.

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IT INQILOBI: UCAV - HAVO JANGINING KELAJAGI?

Annotatsiya: Ushbu maqola axborot vositalari asosida UCAVni an'anaviy harbiy aviatsiya xavfiga qarshi texnik jihatdan qodir va iqtisodiy jihatdan samarali echim sifatida foydalanishni taklif qiladi. Maqola, axborot texnologiyalari, sun'iy intellekt va ularni qo'llash sohani inqilob qilib, paradigmatik o'zgarishlarni keltirib chiqarishi mumkinligini ta'kidlaydi. UCAV foydasiga argument 4-avlod jangchilarni to'ldiradi va avlodlarning o'ylashi uchun raqibdir.

Kalit so'zlar: axborot texnologiyalari, uchuvchisiz havo vositalari, dronlar, UCAV, mudofaa, kosmik sanoati, sun'iy aql.

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Introduction

Unmanned Combat Air Vehicles (UCAVs) are a category of Unmanned Aerial Vehicles (UAVs) that are designed to fire munitions and are characterized by increased autonomy of operation. Key attributes coupled with UCAVs, as defined in conventional military jargon, include an unmanned counterpart of a manned attack or fighter aircraft. This necessitates such capabilities as range, high speeds and a significant weapon load. Another key salient of UCAVs is the broad requirement for UCAVs to survive engagements rather than be used in one-way kamikaze strikes. UCAVs operational today are largely restricted to small, lightly armed derivatives of more conventional UAVs.1

UCAVs are an emerging technology that has the potential to revolutionize air warfare. While the 5th generation of combat planes today is the pinnacle of military aviation, UCAVs present paradigms that can supplement if not supplant them. Subject Matter Experts (SMEs) who discuss a potential 6th generation inevitably mention unmanned aircraft as a possible key salient.2

This paper focuses on UCAVs in a function as air-to-air combat vehicles focused on air superiority missions. The paper is in exclusion of other roles such as air-to-ground and Intelligence, Surveillance & Reconnaissance (ISR). It is recognized that UAVs are highly effective in both these roles and this exclusion in no way implies the belittlement of these key aspects to UCAV and UAV technology.

The paper considers the advantages, disadvantages, technology and politics and how this could potentially relate to a nation's threat perception. It offers a specific solution tailored for the Subcontinent.

The Advantages of UCAVs

Long Range Beyond Visual Range Air-to-Air Combat

The world is increasingly converging towards long range air-to-air combat, not only with increasingly sophisticated radars3 that negate stealth4, but also AAMs like the ASRAAM and the A-Darter that provide an improvement in range of IR-based missiles (Defense Industry Daily, 2010). Pilots engaged in BVR combat perhaps have the least value added to combat; essentially, they monitor their sensor-suite, communicate with controllers and then fire a missile which then takes over the task of actually destroying the target. An F-pole style maneuver or other similar maneuvers are limited by the G-forces that the pilots can sustain. Dodging incoming BVR missiles, fired from enemy aircraft is again limited by the G-forces the pilot can handle. The case for a UCAV in this form of combat is arguably the strongest after ISR.

Short Range within Visual Range Combat:

To consider WVR combat, let us visualize what is achievable with the state-of-the-art at present in the form of the F-35. We will later consider how much better a UCAV can exploit these advantages than a manned pilot.

In a post-merge scenario where a large number of friendly and enemy aircraft are embroiled in a dogfight, identifying friend-or-foe and firing at a target can become both critical and yet complicated. When a fraction of a second counts, the human pilot has to analyze his MMI and make a quick choice. The F-35 helps this critical process by providing an MMI that keeps track of all aircraft embroiled in the fight and displaying them in the most user-friendly method possible.

The process sounds difficult, but is only so for a human. A computer can analyze aircraft shapes easily. Situational awareness, whether human or computer-enabled, allows a fighter aircraft to assign missiles for targets as soon as a picture of the battle-space has been formed. With HOBS missiles, the execution is relatively simple even for a less maneuverable combat aircraft.

Another element added by the F-35 is interconnectivity or swarm logic. Once situational awareness has been achieved by man or machine and the fighter aircraft knows where the friends or foes are, and at the same time can communicate with the rest of the friendly fighter aircraft who also share the same picture of the battle-space, computers can execute complex plays in a team format. This creates a veritable soccer match were one side knows exactly what is going on in the entire football field and the location of its players. As a result, they can significantly outplay the opposing team. Such strategies may include providing cover fire, cross

fires, gambits and other game-theory based plays5. All such maneuvers can take place pre-programmed and at speeds, G-forces and time frames not possible by human operators. Swarm tactics have already been demonstrated by US aircraft manufacturers in their UCAV programs (Jaquish, 2004).

Can a human operator compete? Kasparov may or may not be able to beat Deep Blue on a given day. However, to do so while sitting in a fighter cockpit, facing G-forces and in the time constraint of fractions of a second, the victor becomes all too obvious.

Human operators can always be put in the loop where necessary, but a UCAV can easily handle many tasks autonomously, and like an attack dog, only need to be pointed at the enemy. The UCAV can take off, fly a designated route, destroy targets and awaiting instruction or flying back to base, dodging missiles and being fully aware of many factors pilots often forget - being aware of status of weapons, fuel supply, location of enemies and friendly forces, ground units and whether weapons doors are open or closed. It can think of all this simultaneously and do so without mistakes, under any amount of stress, either physical or sensory.

Low Costs:

UCAVs can be manufactured and operated at a tiny fraction of the cost of manned fighters. Quality pilots are a rare commodity and are hard to find, train and keep operationally ready. They also take a considerable amount of lead-time to train effectively. Another aspect is the low maintenance and operational costs due to not having a requirement to constantly fly aircraft. This also means that many important systems do not need to be as reliable or have high MTBF (Mean Time Before Failure). After all, if the UCAV is not endangering a pilot's life, does not fly frequently and is cheap to manufacture, they need not be as durable. UCAVs need only be flown during wartime or during high tension periods.

This means that their subsystems can be built more cheaply, a key cost element particularly in combat aircraft engine technology. However, some caution needs to be placed as to how far reliability can be compromised as this can be a double-edged sword with accidents and mishaps also effecting costs (Lewis, 2002).

UCAVs may also be cheaper because many expensive elements in a modern fighter relate to the pilot. For instance, cockpit glass is an exceedingly expensive item. Ejection seats, life support

systems, cockpit avionics and targeting systems and the sheer space, bulk and weight savings all go to make UCAVs significantly cheaper than manned alternatives6.

Due to modern network centric warfare, not all UCAVs need have sensors. Expensive AESA radars for instance can be avoided in but a few aircraft within a "pack". These can often be a manned fighter that orchestrates the package, perhaps preferably a twin-seater, or even be managed by ground controllers / radars or airborne AWACS.

A small UCAV built from an existing parts bin of spare parts can lower costs significantly. We shall discuss further about this aspect later in the paper.

Quantity versus Quality:

Most nations including the United States and China are increasingly fielding sharply smaller quantities of later generation fighters because of the cost and complexity. UCAVs can be produced cheaply, at a small fraction of the cost of modern fighters and can be mass produced for war. As Joseph Stalin once said, quantity has a quality all its own. As modern 5th generation aircraft increasingly resemble flying Tiger tanks, a cheap, simple solution may just prove be the equivalent T-34 equivalent in modern warfare.

Kamikaze:

UCAVs can go into combat disregarding whether they need to come back or not. While fighter pilots may have similar patriotism, operationally air forces for moral and morale reasons prefer to have an exit strategy unless in the most extreme of circumstances. UCAVs make kamikaze strategies practical not only during desperate phases of the war but viable from Day 1. In BVR combat, this becomes an interesting aspect as there is always a tradeoff between the distance a fighter shoots its missile from (and thus how effective this shot will be), and how likely the plane is to come back intact.

This proposition is even more tenable because UCAVs may prove to be significantly cheaper than their manned enemies and the tradeoff would favor the UCAV operator. Most vitally, UCAVs employing such tactics would have a drastic impact on the enemy's psychology. The Rand Corporation expresses this doctrine best in the following words:

Aerospace power will tend to perform best when the desired outcome involves affecting adversary behavior rather than seizing and holding terrain.

-RAND Corporation

The Disadvantages of UCAVs

Tackling the Problem of Jamming:

One of the first responses to proposals for UCAVs is whether they will be able to communicate in the event of jamming by the enemy. When we discuss UCAVs, we often have the image of a Predator operator sitting in some trailer guiding the plane and wonder what would happen to the Predator if that link was lost. The first element to consider is that today's Air-to-Ground based UAVs such as the Predator need a high proportion of the human element because of the vagaries of today's COIN and CAS operations. High bandwidth data transfer such as video streaming is assumed to be an integral part of UAV operation. This does not have to be true for UCAVs. Identifying friend-or-foe can be significantly easier in an air-to-air battle, particularly with mature IFF technologies. This is true particularly in where the direction of enemy inbound fighters is well known and the environment is best described as sensor rich.

The end result is that, a highly autonomous UCAV will not need constant connectivity but will need to be assigned a task and given instructions for post-task completion. For instance, if after destroying enemy aircraft no other enemy aircraft are found in the vicinity and no instructions are forthcoming from friendly forces, the UCAV may simply be programmed to return to base. In case of fear of electronic warfare incapacitating or overriding the UCAV, a controller may pre-program the UCAV to not accept signals from a specified time period forward. To accomplish the given mission and either go back to base or move to a specific geographical area deep inside a nation's territory and receive specific directional signals for further instructions.

In this scenario, a UCAV can still be jammed from being operationally effective, but manned aircraft will suffer to the same extent as the UCAV. Even a 5th generation aircraft without AWACS or other auxiliary support will be vulnerable. Another point is that modern communications, even Link 16 is exceedingly hard to jam. Directional communication links are also increasingly mature and near ideal for UCAV use.

Human Element:

Despite all the advantages of a UCAV, the human element cannot be fully substituted, whether one with Artificial Intelligence (AI-UCAV) or a more conventional model. There will always be an opportunity for a fighter pilot to think outside the box. This will continue to remain a weakness of UCAVs. Carlo Kopp mentions the two ideological extremes in UCAV literature, one looking at UCAVs as a "dumb RPV" while the other trying to build a James Cameron's "Terminator" and suggests a moderate approach between them may be most appropriate (Kopp, 2001).

Reasons Why the West is Being Held Back

Their Politics:

Many technology choices made by the United States and her allies are not based on merit alone but are made because of political reasons. USAF officers for instance, would not like UAVs to take over jobs of their pilots. An example is the Congressional deadline for the USAF to field a third of its force as UAVs by 2010 (Jaquish, 2004). The

USAF considered a Predator that can fire its own missile a bad idea and this was not overturned until the CIA used them with great success. Even when forced to fly UAVs, they have insisted on using pilots to fly the UAVs. The US Army proved otherwise when they began using NCOs instead. Another glaring example of the organizational hubris of the US armed services is in their Joint Vision 2020. There is not one mention of UAVs or UCAVs, nor a single picture of one in a paper that has over 50 images of tanks, submarines, fighter jets, warships, transports and refugee camps7.William Lewis (Lewis, 2002) also complains about the long lead times in acquisition and procurement within the US armed services.

This bias in the USAF and perhaps in other Western air forces is a key reason for why UAVs in general and UCAVs in particular, have not made breakthroughs in the scale anticipated with technologies now available. History has shown that it often takes a major shock in the form of a war to change perceptions, as was seen in WWI, WWII and to a lesser extent the subsequent wars up to Gulf War II. What we do know is that the people closest to knowing the feasibility of technology in building operational UCAVs are putting their money in this technology. Boeing, Northrop Grumman and General Atomics have spent their own hard cash in researching and developing new UCAVs without formal requests or interest from the USAF.

The Technology behind UCAVs

The technology for fielding real UCAVs has many critical areas that are already proven and mature. Many of the technologies are in fact only waiting to be integrated together. Consider the example of autopilot computers that can now takeoff, fly to a destination and land a commercial aircraft. This technology is operational in the commercial airline industry and is considered mature today. Pilots can merely take control when something untoward happens and requires out-of-the-box thinking. (Garlick, 2017)

An American Global Hawk today can take off, fly around the world, accomplish its ISR mission and come back to base making a perfect landing, with no manual input. A JSF is being designed with the ability to visually track a large number of targets, identify and categorize them without any human input. Modern missiles can defeat maneuvering fighters by employing multiple tactics, even being able to come back in case it missed the designated aircraft in its first pass. Again, all this is accomplished without input from a human.

Diffusion of Technology Worldwide:

The technology to build manned fighter aircraft has traditionally remained within a handful of nations such as Russia, USA, China, France, Sweden and the United Kingdom. This monopoly of technology has been a major issue particularly vis-?-vis the West and the Rest of the World. UAV and UCAV technology on the other hand, has been far more diffused throughout the world. Smaller countries and countries with little previous record of aircraft manufacture, such as Israel, Austria, Italy, Spain, Belgium, Switzerland, Turkey, among others are making significant contributions. For instance, Camcopter, a product by a small, hitherto unknown Austrian company Siebel, has sold a large number of its UAVs including over 80 to the UAE (Wezeman, 2007). What is even more interesting is that a number of parts will be manufactured by such an unknown as the UAE Research and Technology Center. It may also be noted that even within the US military-industrial complex, it is General Atomics as opposed to Boeing or Lockheed Martin that has stolen the lead. From these examples and a number of others, the technology behind UCAVs is realizable by firms outside of the traditional countries and corporations that had earlier dominated military aviation. The UAV industry is by all indications Schumpeterian and remains wide open to any country or company.

Golden Opportunity to Pull Ahead:

If a country's security apparatus can do better and avoid institutional and political barriers that the West is plagued with, they can make a relative leap in capabilities and meet their goals and objectives far better than a linear and asymmetric solution could. With a UCAV, a country could achieve the next major milestone. A country's aircraft manufacturing industry would remain relevant rather than become outdated and relegated to obsolescence. Many nations do not have the technology or the resources to build an expensive and complex 5th generation plane. A UCAV however, is a far more achievable goal. As we shall see later, the technologies involved allow far greater flexibility and may be ideally suited to many developing country's military-industrial complex's strengths.

Possible UCAV solutions for Future Air Combat

Establishing a requirement first requires the establishment of a doctrine. This is a critical weakness for the European Union were divergent needs are hard to align and researchers often have to work on the basis of practicality (Freitas, et al., 2009). As concerns an increasing number of air forces, there is a clear threat scenario and easier possibilities of establishing a doctrine. Based on an outlined doctrine, we can consider a number of possible UCAV solutions for an air force tackling the future threat scenario of 5th generation aircraft. Particularly for countries that cannot afford to purchase such highly expensive aircraft in numbers that matter. This means they have to find asymmetric strategies to counter the threat.

Two possible scenarios appear within a broad asymmetric strategy - positive asymmetry or negative asymmetry. Examples of implementing a negative asymmetric scenario against an IAF fielding significant numbers of 5th generation fighters would be to push back defenses further away from the border, rely more on LR-SAMs and resort to hardening major assets against the inevitable.

A strategy of positive asymmetry is also possible. This would imply responding asymmetrically but in a more proactive, aggressive and positive manner. This paper will outline such a strategy. As an example of such a strategy, a country can choose to skip the 5th generation concepts and move towards combining the most practical of the 3rd, 4th and 5th generation with concepts deriving from the 6th generation; a simplified UCAV to supplement 4+ generation fighters. This approach will not be unique. Japan for instance, may choose to skip the 5th Generation concept with its i3 fighter concept (Perrett, 2010).

In Conclusion

UCAVs are an emerging technology that has the potential to revolutionize air warfare. While the 5th generation of combat planes is today the pinnacle of military aviation, UCAVs present paradigms that can supplement if not supplant manned fighters of the 4th and 5th generations. People who discuss a potential 6th generation inevitably mention unmanned aircraft as a likely salient. Unlike the 5th generation of aircraft that are extremely expensive and complex to build and maintain UCAVs provide the potential of finding an equivalent solution with significant reduction in complexity and cost.

While nations struggle to keep their 4th generation aircraft operational and can barely dream about 5th generation solutions, UCAVs provide an interesting paradigm shift that cannot be ignored by those entrusted with the defense of their nations and peoples. For some, UCAVs may be the only realistic way to counter a large number of 5th generation planes.

References

1. See Siemon Wezzeman "UAVs and UCAVs: Developments in the European Union", 2007 for a more detailed definition of UCAVs.
2. See Annual Industries Capabilities Report 2009 published by the Office of Under Secretary of Defense, Acquisition, Technology & Logistics, Industrial Policy Report regarding the capabilities expected from a 6th generation fighter aircraft.
3. See Bertnes et al "A Brighter Future for Gallium Nitride Nanowires", 2006 for a discussion of the Gallium nitride technology and its application to radars.
4. See Perrett "Japan Keeps Pilot in 6th-Gen Concept" 2010, for a reference to increased range and anti-stealth characteristics with data fusion from multiple sensors.
5. See Bessemer "Transitioning to Unmanned Combat Air Vehicles" 2006, for a detailed discussion of game theory and the Nash Arbitration Model.
6. See William Lewis, "UCAV, the Next Generation Air-Superiority Fighter?" 2002, for a more detailed discussion of cost comparisons