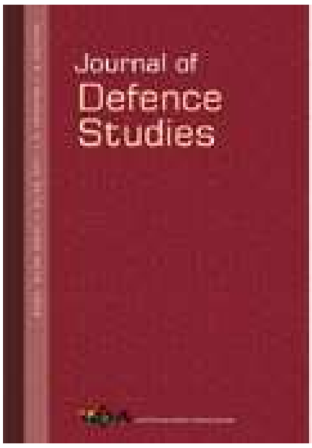

Journal of Defence Studies

Publication details, including instructions for authors and subscription information:
http://www.idsa.in/journalofdefencestudies

Debating Lethal Autonomous Weapon Systems

Ajey Lele

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Technology and the armed forces have a symbiotic relationship. Many technologies which are presently used in day-to-day life, like the Internet or navigation systems (global positioning system [GPS]), actually have a link to, or are derived from, military innovations. Artificial intelligence (AI) is one arena of present generation technology that militaries have been developing mainly for two purposes: first, for juxtaposing it on their existing defence architecture for its performance enhancement; and second, for developing new types of militarily instruments and weapon systems. The research and development to advance new lethal autonomous weapon systems (LAWS) has been bearing good results and a few such systems have already been fully operationalised. It is expected that ongoing advancements in LAWS is likely to establish a different context for their military applicability. This article discusses various aspects of autonomous and lethal autonomous weapon systems.

Introduction

Throughout the history of warfare, weapons technology has been advancing to enable attack from ever-increasing distances. From stones to pole weapons and bows and arrows, from cannons to aerial bombing and cruise missiles, attacking the enemy has become ever easier.[1] For some time now, standoff weapons and precision-guided weapons have been used in greater numbers in warfare. In fact, direct human involvement has been reducing in modern warfare over time, especially due to the induction of robotic technologies. Presently, drone technologies are changing the

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ISSN 0976-1004 print

Journal of Defence Studies, Vol. 13, No. 1, January–March 2019, pp. 51–70

nature of battlefield with the armed forces remotely controlling warfare in a limited sense.

The advancements in the autonomy of modern-day weapon systems can also establish a different context for their military applicability. Such weapons may not necessarily disrupt any specific conventional weapons or weapon systems but they could have a more lasting disruptive impact on the existing methods of war fighting. An example is the lethal autonomous weapon systems (LAWS) that are slowly making their way into the battleground, with the possibility that further maturation of this technology could shape the nature of future battlefields.

The expanding use of autonomous weapons (robots and other weapon systems) on the battlefield is thus expected to influence the battles of tomorrow. They could be the catalyst for a transformation that will eventually result in a revolution in military affairs (RMA).[2] The basic purpose of employing military robots is to undertake tasks that are difficult for human beings to handle. Broadly, the evolution of robotics can be said to have started with the premise that the soldiers' lives should not be unnecessarily put in danger. Essentially, the idea was to have weapon systems which could offer certain tactical advantages on the battlefield. At first, people were of the opinion that autonomous weapons would be more or less robots that would be used on a battlefield, hence having more of a tactical utility. However, the concept of LAWS is much 'deeper' and does have larger strategic significance too.

It can be argued that the debate on this subject is still evolving. There is another important aspect that is being debated heavily: 'should the choice of decision making to take human lives be given to machines?' A global resistance mechanism is, in fact, evolving against such weapons and there is a view that such weapons should be banned.[3] Strictly speaking, from the perspective of artificial intelligence (AI)-based weapons development, it appears that defence equipment manufacturers are likely to find it difficult to exploit the full potential of AI to design and develop weapons. Also, the positions taken by states like the United States (US), France, China and Russia will play a role in deciding whether AI would revolutionise the global military industry complex.

This article thus identifies and analyses military applications and implications of modern-day LAWS. Additionally, the article explores the contemporary debates that surround the use of such systems.

Historical Context[4]

On tracing the history of development of autonomous technologies, it becomes evident that this concept is not of recent origin. The scientific community in general and defence technology developers in particular have been fascinated with the idea of allowing machines to perform tasks independently for many centuries. Obviously, autonomous weapon systems (AWS) have evolved gradually over a period of time; and the past history provides a glimpse of these developments. It would be incorrect to judge every system in this journey as fully autonomous. At places, autonomy was for the entire system, where minimal human effort was involved, while in certain other cases the AWS were found mounted on weapon delivery platforms operated by humans.

Surprisingly, lethal autonomy has a long history. In the works of Leonardo da Vinci (1495), sketches have been found giving designs of a 'mechanical knight' capable of mimicking a range of human motions by using a system of cranks and pulleys. The famous Serbian-American inventor and futurist Nikola Tesla (1898) has been applauded for developing the first wireless remote-controlled vehicle (a small iron-hulled boat). He is also credited with ideas like developing radio-guided torpedoes. Subsequently, World War I witnessed a series of advances in robotic warfare, including the US-made Kettering 'Bug' (a gyroscope-guided winged bomb) and the German FL-7 wire-guided motorboat, loaded with hundreds of pounds of explosives. During World War II, Nazi Germany (1942) used Goliath remote-controlled mini-tanks. They carried 60 or 100 kilograms (kg) of high explosives to destroy targets, like tanks, bridges and buildings, by undertaking the detonation of their warhead. During the 1980s, various research programmes with potential military applications emerged, such as the US Army Tank Automotive Command (TACOM). The Defense Advanced Research Projects Agency (DARPA) also developed an advanced ground vehicle technology and the Naval Ocean Systems Center worked on Ground Surveillance Robot (GSR) for the Marine Corps.

During the 1991 Gulf War, US forces used the Low Altitude Navigation and Targeting Infrared for Night, or LANTIRN system, for increasing the combat effectiveness of the fighter aircraft—the F-15E Eagle and F-16C/D Fighting Falcon—as well as the navy's F-14 Tomcat. This system contains a navigation pod and a targeting pod mounted externally beneath the aircraft. It allows the aircraft to fly at low altitudes, at night and under the weather, to attack ground targets with a variety of precision-guided and unguided weapons. Over the last three decades, the system has seen various upgrades. It may be noted that LANTIRN by itself has no lethal capability and cannot be categorised as LAWS, but it is an autonomous system which is used for military purposes.

The TESSA LANTIRN upgrade is expected to increase acquisition, identification and weapon employment ranges by a factor of four over the earlier generation system. It incorporates an automatic target cuer (ATC) to assist the weapon systems officer (WSO)/pilot in the detection and identification of targets in the viewing area. The upgrade increases the standoff range (four to five-fold) for autonomous detection, acquisition and attack of time-critical targets. Here, the autonomy should be viewed in a limited sense restricted to quick decision making done by the system by incorporating all the available inputs. For pilots flying those machines, it is humanly impossible to take any flying-related decision in a fraction of a second.

One system which almost got global recognition during the Gulf War was the US Navy's Tomahawk missile. In fact, the Tomahawk can be considered as one of the important autonomous systems present in the US armoury during the 1990s. Certain weapon systems used by the US Army, like artillery-launched weapons, the Brilliant Anti-Tank (BAT) and terminally guided warhead, are also known to belong to autonomous variety. In addition, systems like sentry robots, systems mostly involving ground robots such as PackBot, TALON and MARCBot, supersonic and stealthy drones and space planes are either in the making or have been declared operational for use.

Defining AWS

The meaning of the word autonomous varies in literature, but there appears to be a broad agreement on the meaning of the word autonomous as an independent system. Hence, AWS can be considered as systems which can accomplish the mission independently (without any human intervention). One of the consigned definitions of AWS is as follows: 'Any weapon system with autonomy in its critical functions—that is, a weapon system that can select (search for, detect, identify, track or select) and attack (use force against, neutralise, damage or destroy) targets without human intervention.'[5] When the lethality element is added, then such systems are designated as LAWS.

Various debates and discussions on AWS indicate that, broadly, there is a global agreement about retaining human control over these

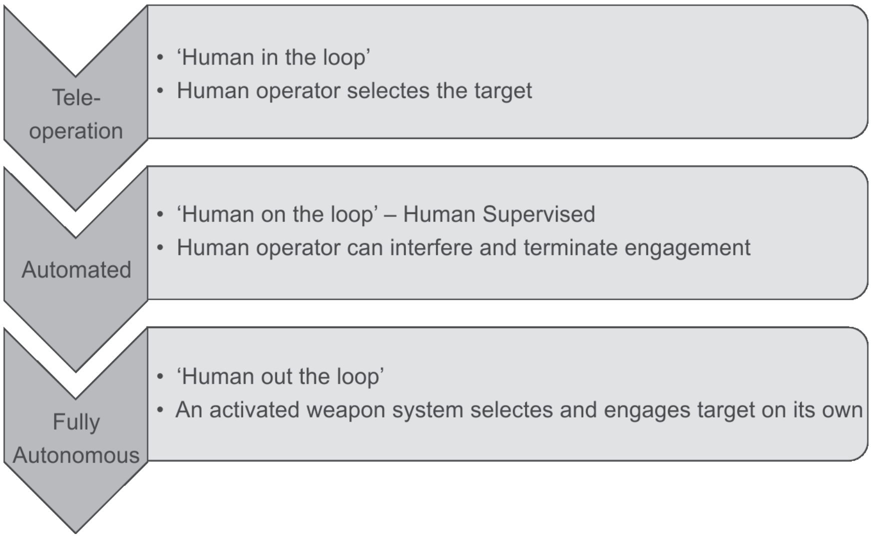

Figure 1 Types of Autonomous Systems

Source: Author, based on information available in the public domain.

weapons. However, there appears to be disagreement surrounding the characterisation of meaningful human control.

A foolproof definition of LAWS is not possible because it is difficult to judge what action amounts to 'lethality'. For example, it is often argued that cyberwarfare is bloodless warfare. However, it actually depends on the purpose behind the attack. Suppose cyber methods are used to create a flash flood by manipulating the doors of a dam. Then, such an act would end up killing many people. Similarly, it is important to factor the end result of the action of the use of AWS.

Classification of LAWS

Generally, in militaristic sense, words like robots and AWS are often used interchangeably. However, there are certain nuanced differences. A robot can be viewed as a mechanical creature functioning autonomously. Correspondingly, what makes AWS distinctive midst weapons and different from the commonly used vehicles or weapon systems (unmanned aerial vehicle [UAV] or unmanned combat aerial vehicle [UCAV]), better known by the name 'drones', is that they are fully autonomous. Nonetheless, the term 'autonomous' is ambiguous and mainly depicts relative independence of the system than total autonomy. As presented in Figure 1, there are broadly three levels of autonomy: tele-operation (such as the Reaper and Predator drones); automated (for example, the Global Hawk surveillance drone); and fully autonomous (such as the Aegis Combat System).

Tele-operation is about humans having remote control and has a long history (Great War era); and many such systems are deployed in armed forces currently. The next level of autonomy is 'automated' or 'semi-autonomous'. Such systems operate 'within pre-programmed parameters without the requirement for a command from a human. For example, the intelligence, surveillance and reconnaissance UAVs, known as the Global Hawk, are automatic because their flight commands are controlled by on-board systems without any human intervention (but mostly human monitoring continues). Finally, the autonomous systems are ones which have the highest level of autonomy. Such systems decide on their own about their operations and can even learn and adapt to new information.

As mentioned earlier, in the last few decades, the armed forces have been increasingly depending on various emerging technologies. Owing to numerous modern-day challenges, they are making additional investments towards possessing weapon systems which can also handle non-conventional and/or asymmetric tasks. Rapid technological developments are bringing in more autonomy to the weapon systems. Militaries are graduating from semi-autonomous to fully autonomous systems.[6] At present, 'dumb' systems which are capable of operating autonomously do exist, such as the Aegis Combat System that automatically identifies, targets and engages incoming threats. Though most present-day AWS continue to relate with 'human in the loop' concept,[7] the trend seems to be moving towards 'human on the loop'. In the former category, humans are actively involved in the decision-making process and in the latter, humans have the flexibility to interfere and terminate the engagement if deemed necessary. The third category, that is, 'human out of the loop', is still a contested concept as it makes humans mere observers of the loop. The entire chain of decision making to implementation is left at the discretion of a machine. These debates on full discretion to a machine, or not, come with their own sets of pros and cons that need to be studied for a holistic understanding of LAWS.

Advantages and Limitations of LAWS

For militaries, autonomous systems offer many advantages.[8] They have the potential of being 'faster, better, cheaper' systems. Success of such systems would depend on the level of AI employed (that is, level of development of AI). The cost of such systems could be one-third the cost of manned platforms and may cost two-thirds as much to operate. More importantly, the system design would not be constrained by the incorporation of life support systems. Normally, it has been observed that all this frees up critical space and weight and allows development of smaller and stealthier systems. In addition, this allows increase in range, endurance and persistence, as well as minimising the logistics footprint. The process of launching an attack by using the weapon systems remains totally professional. Machines can take split-second decisions based on various intelligence inputs and other required information. Other big advantage is that since there is no human presence around the weapon system, certain problems associated with the environment do not matter. Absence of humans allows the system to mount an attack under any high threat situation or in nuclear, chemically or biologically contaminated environments (investments in specific suits for humans, etc., is not required).

In the context of present level of technology development, there is nothing called total autonomy. Science fiction scenarios like robots running amok are yet to become a reality. Present-day robots do not possess the ability to sense or smell, and cannot plan on their own in response to the prevailing 'environment' at that point in time. Generally, there are no robotic agencies which would decide on their own to start work and deploy AWS which, again, will independently decide the nature, type, target and place of attack. Actually, the weapon systems in service or production today can be said to have limited autonomy in that sense. Present-day systems are autonomous after launch. They are pre-programmed for a limited/specific task. After the system gets activated—based on the knowledge gained by the system—and takes the decision to fire, there is no looking back. Very little possibility exists for the system to change the target/s or decide against firing, because machine has no situational awareness from the point of view of taking a decision to kill or not to kill. Getting into the legality of the debates encircling LAWS also calls for understanding the offence-defence nature of such systems. Nevertheless, all scenarios involving LAWS indicate that, though at a distant level, some form of human involvement will always remain.

Offensive and Defensive Weapons

It is well known that 'the best defence is a good offence'. Generally, more than the type of the weapon, what is important is to decide whether it is defensive or offensive in nature. Defensive warfare is about military operations conducted towards defending one's territory, while offensive warfare involves starting the war first and, at times, also involves expanding the territorial borders of the state. However, it is important to delineate the difference between defensive warfare and defence weapons. During defensive warfare, both defensive and offensive weapon systems can be used. In a conventional warfare setup, a weapon envisioned for use in spoiling an incoming attack can be considered a defensive weapon, while the weapon used to initiate an attack can be considered an offensive weapon. However, after the war begins (it would be defensive warfare for one agency and offensive for other), every weapon system used can be considered as an offensive weapon system.

The first known automatically triggered lethal weapon is the land mine. Such mines have been used in warfare possibly since the 1600s. Naval mines have been in use since the 1700s. There is a ban on the usage of anti-personnel mines as per the 1997 Ottawa Treaty, that is, the Anti-Personnel Mine Ban Convention, or the Mine Ban Treaty (1999). However, many states in the world are not signatories to this treaty.

Interestingly, nuclear weapons, which are essentially considered as tools for ensuring deterrence, may be viewed as defensive weapons. Hence, it is argued at times that there is a very thin line between offence and defence category of weapons. On similar lines, LAWS could also be considered to fall in the category of either offensive or defensive systems. However, normally, fully autonomous systems are expected to belong to the defence category. This is because it may not be possible for a weapon system to choose a target on its own since no machine can decide why, when, where and how to start a conflict unless, and until, it is programmed to do so. Hence, LAWS are considered more as defensive weapon systems, that is, systems which respond to an incoming threat. Almost all the prevailing AWS (mainly used in missile defence role) are systems designed as point defence or area defence weapon systems. Such systems respond to any incoming missile threat but do not have capability to launch an attack all by themselves.

Till date (possibly), no weapon system has been designed and programmed which can decide to start a conflict on its own. Occasionally, the US defence agencies have operated a few ground robots, like PackBot and SWORDS in the Afghanistan theatre during the military campaign post-9/11. Such robotic systems have limited inbuilt AI and have the capability to decide to open fire on their own. Such systems indicate that, in future, some autonomous systems could be designed and developed that have the capability of firing on their own, and hence these could get categorised as offensive weapons. However, these systems have also been frequent targeted by the academic community regarding ethical and legal issues. The pertinent question remains of how the machine, which equally identifies a battle tank and an old lady on a wheelchair as set of bits and bytes, can be responsible for decision making. This has brought into focus the importance of shaping a legal framework and governance rules such that these systems continue to work in sync with humans and not against them.

Governance of LAWS

Since drones have become a central instrument in armed conflict, the legality of their use is increasingly under question for a variety of reasons. At the same time, drones have many civilian usages too (for example, drone photography), which indicates its dual-use nature. There are legal and ethical questions pertaining to various drone technologies, particularly for the drones which fall in the category of LAWS. In the twenty-first century, the use of drones in military combat operations is legally one of the most controversial issues confronting International Humanitarian Law (IHL) and the Law of Armed Conflict (LOAC).[9] In the recent past, various states have formalised their policies for use of drones, though the process is expected to remain dynamic. Drones as LAWS can be considered a test bed for evolving a legal architecture for use of LAWS. Today, various technological and policy aspects of this technology are known and some legal clarity is emerging. However, in general, it needs to be appreciated that the debate on LAWS is of recent origin and it would take time for developing a comprehensive legal agenda.

Presently, various attempts are being made to understand the technological foundations of autonomy; applications and capabilities of LAWS; and their legal, ethical, socio-economical, operational and political character.

Since 2013, the governance of LAWS has been debated under the framework of the 1980 United Nations (UN) Convention on Certain Conventional Weapons (CCW). The discussion, however, remains at an early stage as most states are still in the process of understanding the technology and its implications. Presently, globally recognised non-governmental organisations/think tanks, such as the International Committee of the Red Cross (ICRC) and Stockholm International

Peace Research Institute (SIPRI),[10] are debating and researching about the nature and future of these systems. Organisations connected with the UN are also showing interest towards debating this issue. According to Izumi Nakamitsu, Under-Secretary-General, High Representative for Disarmament Affairs:

> although there are no technical barriers to deploying LAWS that could target humans or act in or near civilian areas, there are arguably normative barriers. Through the discussions that have already taken place informally under the auspices of the Convention on Certain Conventional Weapons (CCW), there appears to be an emergent consensus around the view that target selection and engagement decisions should not be entirely delegated to machines.[11]

Realising the immediate need to engage state actors in this debate and to identify the possibilities as to what preventative measure could be taken on this subject, the UN has established a Group of Governmental Experts (GGE) on LAWS in 2017. One common understanding amongst the majority of states is the importance of retaining human control over weapon systems, including control over both the selection and engagement of targets. Another general risk highlighted by a number of countries is that of proliferation, and maybe even a race for autonomous weapons.[12]

The delegation of decision making to machines, especially those decisions pertaining to life or death of a person, is a recurring concern of those who oppose AWS. Highly regarded scientists and scholars have called for a ban on 'lethal autonomous targeting' because it violates the 'Principle of Distinction' under IHL; that is, AWS will find it very hard to determine who is a civilian and who is the belligerent in instances of conflict, which is difficult even for humans in many instances. The persistent fear among individuals is that allowing AI to make decisions about target engagement will most likely result in unacceptable collateral damage. This would consequently lead to another major concern, 'accountability'. As per the requirements of *jus in bello*, 'any weapon or other means of war that makes it impossible to identify responsibility for the casualties it causes does not meet the requirements of jus in bello, and, therefore, should not be employed in war.'[13] This issue arises because machines make decisions on their own, so it is difficult to determine whether an erroneous decision is due to flaws in the programme or in the autonomous deliberations of these autonomous machines. The nature of this problem was brought to light when an autonomous car drove too slowly on a highway than the permitted limit, and it was unclear to whom the ticket should be issued.[14] In such circumstances where a human being takes a particular decision regarding a target, there exists a clear chain of accountability, stretching from whoever actually 'pulled the trigger' to the 'commander' who gave the order. However, juxtaposing the same situation on AWS, no such clarity exists. It is unclear who or what is to be blamed or held liable in case of an eventuality.

When talking about the regulations of these technologies, many scholars argue that regulation on such technologies will have to emerge along with the technology because they believe that 'morality will coevolve with technological development'.[15] In addition, they suggest that in the foreseeable future when humans become more accustomed to machines performing functions with life-or-death implications or consequences, humans will most likely become more comfortable with AI technology's incorporation into weaponry.[16]

These arguments establish that it is high time that the states should work on developing norms and principles guiding and constraining research and development—and eventual deployment—of LAWS. Those norms could help establish expectations about legally or ethically appropriate conduct. This even calls for an international treaty or multilateral regime to regulate or even prohibit them if needed considering the accelerating progress the states are making in integrating LAWS with the state-of-the-art weapon systems.

LAWS Redefining Defence Architecture

At present, various available AWS (which are fully operational or under development) are: counter-rocket, artillery and mortar systems, such as Iron Dome; and anti-missile systems, such as close-in weapon system (CIWS), Terminal High Altitude Aerial Defense (THAAD), S-400 and railguns. In addition, there are systems based on robotic technologies, like drones and unmanned ground/underwater vehicles.

In response to a range of threats to ships, which could be from air- or surface-launched missiles or drone aircraft, it is important to have a reliable and effective ship defence architecture. Such architectures are layered systems with multiple lines of defences. The last line of defence is the radar-guided Gatling gun (CIWS), which takes on threats inside a radius of 2 miles.[17] Basically, this is a terminal defence system against attacking cruise missiles.[18] The CIWS, also known as 'sea-whiz', is a system used for defence against anti-ship missiles. In general, this point defence weapon system is capable of detecting and destroying short-range incoming missiles. This system is also useful for engaging enemy aircraft which have successfully infiltrated the outer defences and approach with high speeds towards the target (normally, the battleship or tanker ship). The CIWS can also address threats like shell bombardment and rocket fire. All major maritime forces in the world are equipped with CIWS. This system can also be used on land to protect military bases. Raytheon, a major US industrial corporation, is the main global manufacturer of this system. Such systems have both gun-based and missile variants. The gun-based system comprises of multiple-barrel, rotary rapid-fire cannons (20 millimetre [mm] gun subsystem) placed on a rotating gun mount. Both the variants require various types of passive and active radar units (search and track radars, AN/VPS-2 Ku-band) for providing terminal guidance.

Another interesting development is the electromagnetic railgun. This weapon uses powerful magnets to sling warheads down its barrel and into the air, with the ammunition being fired faster and further than traditional canons. Once fully operational, this weapon has the capability to destroy moving missiles and aircrafts at ranges and accuracy normally reserved for missiles, while also being powerful enough to sink ships.[19] Recently, a Chinese government newspaper has boasted about the new technology that would soon be integrated into their military capabilities. The exact nature of this technology is not known but it appears to have been developed with some sort of a major breakthrough in electromagnetic research.[20] Even the US has been making strides in developing and deploying a powerful electromagnetic railgun.[21]

Additionally, the air defence system for short-range applicability has also proved its effectiveness, especially the Iron Dome, a system conceptualised by Israel and jointly funded through the US. This is a counter-rocket, artillery and mortar system capable of intercepting multiple targets from any direction. This system has been developed by Rafael Advanced Defense Systems and Israel Aircraft Industries as a mobile all-weather unit. Iron Dome is an autonomous guidance and control system capable of intercepting specific targets which represent a high-priority threat according to the system configuration. It is known to be more effective than the earlier systems like the Patriot. At present, the Iron Dome is the most-tested missile shield and its effectiveness is estimated to be around 75–95 per cent.[22] As per the information provided by Israel, as of 2015, this system totalled around 1,500 successful intercepts and there were very little Israeli casualties caused due to failures of this missile shield.[23] This system weighs 90 kg with 3 metre (m)-long missiles and is carried in groups of 20 in each launcher. The warhead is known to carry 11 kg of high explosives. The system is designed to destroy short-range rockets and up to 155 mm artillery shells both during day and night, at distances from 4 kilometre (km) to 70 km. The system is an all-weather system and is known to perform accurately even during adverse weather conditions, like dense fog, dust storm, low clouds and rain. Efforts are underway to increase the lethal range to 250 km.[24] Using an altered Iron Dome missile battery, the Tamir Adir system has been developed as a maritime missile interception system (successful test conducted by Israel in May 2016). This system is capable of engaging and destroying airborne targets with accuracy from a moving platform.

For threats from longer distances, there are options like the THAAD missile defence system, which assists in defending against short- and medium-range ballistic missiles. It is an important component of the US' anti-ballistic missile/interceptor architecture and has been developed by Lockheed Martin and claims to have a 100 per cent success rate. The entire system architecture consists of few other important elements like radars and satellites. The system operates in a fully autonomous mode and when a threat missile gets launched, an infrared satellite detects its heat signature and sends an early warning and other useful real-time tracking data to the ground-based system through a communications satellite. When the threat gets confirmed, a suitable command gets conveyed to sensors and weapon systems. After that, the long-range radar detects and tracks the missile for some time to further improve the accuracy. The tracking data helps to compute the trajectory of the incoming threat missile. Amongst the group of batteries available to address the threat, the most effective interceptor battery is engaged and carries out the interception. The complete process of identifying, engaging and destroying the missile is fully autonomous in nature and known have a very high efficiency.[25]

THAAD is known to destroy the incoming missile in its 'terminal phase'. Unlike conventional anti-missile units, it does not create a massive explosion but is designed to hit it dead on by using infrared-seeking technology.[26] The S-400 Triumf missile defence system is also an effective missile defence system and has been developed by Russia. This long-range air defence missile system is capable of destroying incoming hostile aircraft, missiles and even drones at ranges up to 400 km. The system can fire three types of missiles, creating a layered defence and simultaneously engaging 36 targets.[27] The radar of this system is known to detect targets at a range of 600 km.

THAAD can be viewed as an improvement on earlier similar systems (not necessarily fully autonomous), such as the Patriot missile defence system. During 2017 North Korean crisis, the US deployed this system in South Korea at a location called Seongju. Another recent example of deterrence potential of such systems can be found in the Syrian theatre. Possibly, the presence of Russia's S-400 platforms in the Syrian theatre could have influenced the US strategy of attack against the Assad regime. Even when the US agencies bombarded the Shayrat airbase in central Syria (the one which was believed to be used by the Syrian Air Force to launch chemical attacks), they used the long-range Tomahawk missiles—with a range of 1,600 km—and not the strike aircrafts, probably because of the presence of S-400 system. Interestingly, one more message is palpable from this act: the S-400 system is vulnerable to swarm missile attacks and to low-flying missiles with small radar cross-sections.[28]

China has also deployed an S-400 missile defence system on the Shandong Peninsula, between Pyongyang and Beijing. In fact, China has been extremely unhappy about the US deployment of THAAD in South Korea. It has concerns about the capabilities of THAAD's over-the-horizon radar as, theoretically, it is possible for this radar to collect information inside China.[29] All this essentially indicates that the weapon system can be autonomous and defensive in nature, but its deployment can have wider strategic ramifications.

The Aegis Combat System is one of the oldest AWS still in use. Since the Cold War era (around mid-1970s), the US Navy has been using the Aegis Combat System, an integrated naval weapons system meant to destroy enemy targets. This is a total weapon system which performs all functions automatically, from detection to kill. The heart of the system is an advanced, automatic detect and track, multifunction phased-array radar. This high-powered radar performs search, track and missile guidance functions, simultaneously. It has got a capability for tracking more than 100 targets. Its automatic command and decision element allows simultaneous operations against multi-mission threats, like anti-air, anti-surface and anti-submarine warfare.[30] Various navies in the world, like Australia, South Korea, Japan, Norway and Spain, are using this system.

One of the ongoing projects of the US defence establishment on LAWS is the development of armed drone swarms, the unmanned flying units which fly in formation to achieve the task. This project is being handled by the Strategic Capabilities Office (SCO) at the Pentagon. This Perdix system consists of autonomous drones operating as cooperative swarms of 20 or more flying units. All these drones are launched to achieve a specific goal. Altogether, these flying units are expected to engage in collective decision making and are known to possess self-healing abilities. In case one or more of the drone units are forced to drop out owing to various reasons, then the entire system reconfigures itself automatically for mission completion.[31]

Some important LAWS that are still either at the drawing board level or in the realm of theoretical possibilities also need a mention. These are space-based autonomous systems which could be used to target space-based systems, as well as targets on Earth. Such systems are famous as Rods from God, a kinetic weapon bombardment system consisting of tungsten rods in an orbiting platform (Project Zeus and Project Thor,[32] an interesting Cold War era space missile concept). There exists a possibility that with the overall growth in technology sector globally, it is possible that some capable states could make such systems operational in the near future.

Conclusion

Some of the technologically and financially developed states have made significant investments towards developing LAWS over the years. Such investments can be viewed within the ambit of strategic considerations. Historically, it has been observed that militaries continue to push the technological boundaries and further developments in LAWS are likely to take place owing to aggressive campaigning by the militaries for manufacture of such systems. From a military point of view (particularly for major powers), it is important to remain prepared to address various types of security challenges, including conventional, nuclear and asymmetric threats. In recent times, systems like Iron Dome have proved their utility to address threats from non-state actors like Hamas and Hezbollah, while systems like THAAD have shown their utility in the Korean peninsula more as a deterrence mechanism.

There are differing views regarding the relevance of missile defence architecture globally, essentially based on the individual state's point of view. For some, it is an effective tool for strengthening security and providing a guarantee of non-aggression, while for others, the presence of such systems in their vicinity amounts to security threat and is seen as a destabilising move. However, in spite of for and against debates, such systems are emerging as essential constituents of security architecture at least for some nation-states. It is a reality that presently more than 30 nations have ballistic missile capabilities and naturally possible target states would look for effective counter-measures against such threats. Speed, accuracy, and the element of surprise in respect of any incoming ballistic missile threat provides a very limited time window for any human intervention to address these threats. The effectiveness of any missile defence system will depend on split-second decision making and that is only possible if the defence system is fully autonomous.

The nature of warfare is constantly evolving. Unfortunately, although new forms of war fighting are emerging, the old form of war wedging is not disappearing. Hence, militaries are required to remain doubly prepared to address conventional, asymmetric and nuclear threats.

Cyber power is fundamentally changing the nature and focus of modern warfare. The capability to fight wars in and from outer space is increasing the complicacy of war fighting. An increasingly automated battlefield is expected to add newer dimension to warfare. All this will have a mixed impact on the militaries. States are bound to develop counter-measures (and counter-counter-measures) to the LAWS. For example, any major success towards developing hypersonic weapon platforms (crafts that would travel at a speed 5 Mach or more) could make the missile defence system ineffective. Envisaging such possibilities, THAAD manufacturers are already proposing to develop an extended-range THAAD variant to counter hypersonic glide vehicles.[33] Also, missile defence systems are not capable of countering directed-energy weapons, such as lasers. Presently, scientists are looking for options to counter such weapons too.

It is expected that in the coming few years, various new robotic systems and armed drone swarms could emerge as more effective (and usable) LAWS than the missile defence systems which are, essentially, defensive weapon systems. In general, LAWS would continue to have relevance both as tactical and strategic weapon systems. It is important to note that autonomy cannot be absolute; there may be either a low or a high level of autonomy. Hence, ultimately, militaries would be required to keep these weapons under their effective control and decide about their applicability. They also would be required to effectively navigate the legal challenges, arms control and moral issues, to continue to keep these weapons in their arsenal. Today, for militaries, LAWS provide both opportunities and vulnerabilities. Hence, militaries would be required to juxtapose such weapons on their war-fighting doctrines with due diligence.[34]

Presently, much of the discourse on autonomous weapons is found focusing on legal and ethical issues. However, the militaries are looking at these weapons on two different planes: one, as usable and employable weapons in the warfare; and two, using them as a tool for strategic stability. LAWS are being viewed as destabilising weapons by some and this may give rise to arms race in the future. The deterrence potential (which actually exists) of these weapons is yet to be articulated and advertised correctly. Possibly, it may be bit premature at this point in time to locate these weapons in the existing security dynamics of the nation-states. However, once LAWS are fully developed and successfully tested as weapons, they could disrupt some of the existing weapon systems and even have the potential to disrupt the prevalent nature of war fighting itself. As rapid military technological development is becoming increasingly urgent, the international community will need to take cognisance of the potential dangers of LAWS and ensure that appropriate regulations and legal frameworks are put in place.

Notes

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