Autonomous Weapon Systems: Advantages, Challenges and Solutions

Etkin Getir, MSc(c)

From duct tape to nuclear energy and the Internet, a great number of inventions were developed for military use (Sheposh, 2022). Later on, they were taken out of the military context and put into commercial use and ultimately, changed our lives forever. In modern times, there is a similar research and development process unfolds: The proliferation of artificial intelligence through full and semi-autonomous weapons promises the next revolutionary technological stride. On the other hand; ethical, legal and social implications of Autonomous Weapon Systems (AWS) are perhaps only comparable to those of the nuclear energy.

In this essay, the classification of AWS and the issues associated with these weapon systems will be discussed, followed by a demonstration of how AWS are employed by Republic of Korea Army (ROKA) in the Demilitarised Zone (DMZ) along with the real-life advantages and challenges these advanced weapon systems bring. The essay will conclude with proposed solutions to the problems discussed.

The taxonomy of AWS

AWS are classified under three widely accepted categories based on the level of autonomy (Human Rights Watch, 2012: 2).

a. Human-in-the-loop (HITL) systems:

The weapons which are automated to a certain point but are not able to deliver a kinetic effect without human intervention fall into this category.

b. Human-out-of-the-loop (HOOTL) systems:

Unlike HITL, HOOTL weapons are able to engage the target without human intervention, that's to say, these weapons are able to operate from target acquisition to firing in a fully autonomous manner.

c. Human-on-the-loop (HOTL) systems:

HOTL weapons fall somewhere between HOOTL and HITL weapon systems: The weapons operate autonomously, but humans can override if the necessity arises.

The problems associated with AWS

While it is evident that AWS bring many advantages in terms of efficiency (e.g., better targeting, faster reactions and less humans involved), it is also true that there are certain issues associated with AWS, the most important of which are discussed below.

a. The question of 'meaningful human control'

The concept of 'meaningful human control' is a highly contested one: sceptics and supporters of the AWS and various organisations have different takes on it. Meaningful human control is a notion which indicates to the existence of the features to give human operators enough control over an autonomous weapon to interrupt or override when needed before the weapon system takes a lethal action. The unfortunate happening in which British pilots Kevin Main and Dave Williams were killed due to human operators firing Patriot missiles after a false alarm by the missile battery's computer system (Ministry of Defence, 2003) casts a perfect example of the importance of meaningful human control.

b. Overreliance on AWS in the fog of war

As seen in the aforementioned example of the British pilots, modern-day battle leaves little room for doubt. The fog of war as well as the modern weapon systems

require soldiers (especially those who are operating on tactical level) to make decisions in split seconds. In the case of AWS, this necessity leads the human operator to rely on and act upon the outcome of the algorithm, rather than taking the time to apply careful reasoning and analysis of the situation in hand.

c. Complexity of the systems

Modern weapon systems are so complex that the operators are not fully aware of their features. Advanced weapon systems of today require sophisticated operators rather than the courageous soldier of the past. Moreover, a convoluted UI leads humans to commit errors or make it difficult for them, thereby taking more time, to come up with the right response when needed.

d. Ethical and legal issues

The question of accountability (i.e., who should be held accountable for the deeds of AWS) (Righetti et al. 2018), the ambiguity about the law of war that is applicable to AWS, the problem of preventing AWS from acting indiscriminately and ethicality of an AWS deciding to kill a human are among prominent legal and ethical issues encompassing AWS.

The South Korean Example

a. The background

The 250-km long DMZ established after the Korean War (1950-53) has been ROKA's primary focal point ever since. According to Reuters (2019), ROKA operates 60 sentry points at their side of the DMZ. 250-kilometer-long DMZ is manned heavily by both sides of the conflict: according to various reports, there are approximately 2 million troops ready for battle (Sang-Hun, 2022).

Relying on a highly advanced technology sector and outnumbered (CIA, 2022) by its rival, South Korea had always been in search of advanced weaponry to get the upper hand over the North Korea in the long-standing conflict. Moreover, having one of the lowest birth rates in the world (Worldbank, 2020), Republic of Korea (ROK) had to deal with the manpower shortage that impedes ROKA to defend their side of the DMZ adequately. Consequently, South Korean government took a pivotal step in 2003 to invest in a project that would replace human guards with automated machines, saving ROK on manpower and the expenses and the burdens associated with it.

b. The development of SGR-A1

In 2006, Samsung Techwin (now Hanwha Techwin), in cooperation with Korea University and several other institutions, developed the first prototypes of SGR-A1 autonomous sentries that were capable of surveillance, targeting and engagement - practically everything that the human guards could do. Ultimately, SGR-A1 systems were deployed to the South Korean border of the DMZ -the exact date and time and the number of weapons deployed are unknown since the information is confidential- making South Korea one of the first countries which utilised fully AWS (News, 2014).

SGR-A1 is a stationary weapon equipped with a Daewoo K3 machine gun, a laser rangefinder, an IR illuminator and, most importantly, a pattern and voice recognition software to distinguish humans from animals or from other objects. Even though there is always a human involved in the “decision to kill” according to the official declarations, a number of sources suggest that the weapon has an automatic mode which does not require any human intervention to open fire (Kumagai, 2007).

b. Advantages and Challenges

From a military perspective, it is evident that SGR-A1 systems provide numerous advantages to ROKA. First and foremost, it takes the human factor out of the equation: free of all kinds of shortcomings of humans (e.g., fatigue, one's psychological state, etc.) SGR-A1 automated sentries are capable of fulfilling the role of a human guard in a continuous fashion. Moreover, SGR-A1 can operate with a precision rate that even elite soldiers cannot possibly meet.

On tactical and strategic level, SGR-A1 may contribute to the stability in the DMZ, lowering the KPA leaders' risk appetite. The existence of an infallible weapon systems may deter KPA leadership from devising incursions (Velez-Green, 2015). It is also suggested that AWS are less error-prone and more reliable than humans in identification of the intruders and distinguishing combatants from civilians (Witschge, 2018).

c. The challenges and ethical concerns

However, the flip side of the picture is that SGR-A1 brings considerable challenges for ROKA and ROK to deal with. The very news of the development of a potentially fully autonomous lethal weapon by ROK was met with international outcry. Even though authorities from ROK and Samsung Techwin assured many times that SGR-A1 would always be under human supervision, it was not found convincing by the international community due to the fact that the weapon has a full-autonomous mode, and it was not possible to predict in which manner the weapon would be used during the time of a conflict, especially during the absence of international regulation covering AWS.

Another challenge that ROK and ROKA have to tackle is the potential liabilities that might arise in case of human rights violations. In this respect, overreliance on the

status-quo of the DMZ appears to be a potential problem. Since DMZ is a forbidden zone for all civilians and combatants and therefore all intruders are considered enemy (Kumagai, 2007), even though SGR-A1 is equipped with a pattern as well as a voice recognition software, these features are seldom (if ever) used or tested in practice. Hypothetically, in the unlikely case of an ordinary civilian crossing the military demarcation line, even if the weapon system is used in HITL mode, erroneous decisions may easily be given by human operators, which may lead to violation of international regulations including international humanitarian law.

Proposed solutions

a. Introduction of an international regulatory framework

Considering the fact that AWS provide an indisputable advantage to countries over their adversaries, the only feasible way to force countries to limit the employment of AWS is by international law. Even though some initiatives, guiding principles and publications exist (United Nations, N.D.), a binding international regulatory framework enacted by the UN still doesn't exist. It is proposed that the UN should devise a set of international rules which should consist of the following:

1. Restrictions on the development and employment of certain types of AWS (e.g., HOOTL systems). Countries should be urged to always have a human operator in the loop to supervise the AWS.

2. The obligation of employment of a human operator in a close distance or the obligation of having the weapon platform mounted on the control cabinet to prevent a possible electronic attack to cut down the communication lines between the operator and the weapon system.

3. Certain limitations that should be applied on the use of AWS. These may include ammunition restrictions, operating time and a limit on the number of AWS units that work together (i.e., swarms). Such limitations will not only limit the potential damage caused by the AWS but also urge humans not to rely heavily on the AWS.

Finally, these regulations should be supplemented with immediate sanctions which may be imposed in case of a breach.

b. National policies on AWS

Each country interested in developing autonomous weapons should be urged to declare their national policies on AWS. While it is true that, at some point, these policies might be breached by these countries themselves, the governments of the originating countries can be accounted for against these policies. In this respect, U.S. Policy on Lethal AWS (Sayler, 2021), which clearly states the necessity of a human in the loop, stands out as a good example.

c. Global latency rule

For all kinds of AWS, a globally agreed latency rule -which locks the system for a certain period of time before a lethal action can be triggered- could be introduced. Through the implementation of this rule, the human operators could be able to better orientate themselves to the situation, meanwhile, the organisations who deploy AWS may not need to be concerned about acting immediately to get the upper hand over their adversaries, because the latency rule may apply globally. This could not only prevent similar accidents to that of Kevin Main and Dave Williams but, at the same time, it may push the countries to avoid overreliance on these systems and keep their armies ‘humane’. The global latency rule should be enforced by UN to have the maximum global impact possible.

d. Standardization of UX design

A unified (across all AWS) and intuitive UI design could help human operators orientate more quickly, reduce the time needed to exercise the ‘meaningful human control’. This is a pressing need because it is hardly possible for a human operator to spend his/her whole career using only one weapon system and to get a total command of it. Besides, in practice, most operators are shifting back and forth between overseeing the AWS and various daily tasks, increasing the time until they gain situational awareness.

e. Introduction of global standards

While on the end-user level it may be adequate to devise a regulatory framework and urge nations to follow it, on developer and manufacturer level, the role of professional organisations is of utmost importance. A set of standards that cover the aforementioned suggestions is instrumental to guide the professionals, corporations and developers to divert their efforts on developing AWS that are compliant to the international regulations.

Conclusion

Despite the fact that AWS have been a much-debated topic for more than two decades, there is a clear absence of a consensus over the definition, classification and use cases of AWS as well as the international regulations that could help regulate the field. As demonstrated in the example of SGR-A1 and ROKA, while AWS actually have the capacity to bring efficiency to the military organisations and potentially lower the possibility of armed conflict and violation of human rights, the unavailability of such norms inevitably leads to several issues and concerns. It is envisaged that with the

application of the proposed solutions, these adverse effects can be avoided, and in turn, AWS may be put to good use.

Apart from the international organisations which should devise and enforce the international law concerning AWS, much of the responsibility falls on the shoulders of computer scientists and professional bodies. It is undeniably evident that the research efforts by the computing professionals should be accelerated in coming years and decades to help streamline the development efforts in order to promote ethical and efficient development of AWS and ultimately, make human-AWS interaction more meaningful.

References

CIA. (2022) CIA World Factbook: North Korea. Available from: https://www.cia.gov/the-world-factbook/countries/korea-north/ [Accessed 21 May 2022].

Human Rights Watch. (2012) *Losing Humanity: The Case against Killer Robots,* New York: Human Rights Watch.

Kumagai, J. (2007) A Robotic Sentry For Korea's Demilitarized Zone. *IEEE Spectrum* 44(3): 16-17.

Ministry of Defence. (2003) *Aircraft Accident to Royal Air Force Tornado GR MK4A ZG710,* London: UK Ministry of Defence Directorate of Air Staff.

NBC News. (2014) Future Tech? Autonomous Killer Robots Are Already Here. Available from: https://www.nbcnews.com/tech/security/future-tech-autonomous-killer-robots-are-already-here-n105656 [Accessed 26 May 2022].

Reuters. (2019) Factbox: Some facts about the DMZ separating the two Koreas. Available from: https://www.reuters.com/article/us-northkorea-usa-southkorea-dmz-factbox-idUSKCN1TV071 [Accessed 19 May 2022].

Sang-Hun, C. (2022) South Korea Says Unknown Person Crossed Heavily Armed Border Into North. Available from: https://www.nytimes.com/2022/01/02/world/-asia/korea-dmz-border.html [Accessed 21 May 2022].

Righetti, L., Pham, Q.-C., Madhavan, R., Chatlia, R. (2018) Lethal Autonomous Weapon Systems. *IEEE Robotics & Automation Magazine* 25(1): 123-126.

Sayler, K. M. (2021) *Defense Primer: U.S. Policy on Lethal Autonomous Weapon Systems,* Washington: Congressional Research Service.

Shea, A. (2021) The Legal and Ethical Challenges Posed by Lethal Autonomous Weapons. *Trinity College Law Review* 24(1): 125-127.

Sheposh, R. (2022) Scientific and Technological Advances of World War II, *Salem Press Encyclopedia*. Available from: https://search.ebscohost.com/login.aspx?-direct=true&db=ers&AN=154936607&site=eds-live [Accessed 14 April 2022].

United Nations. (N.D.) Background on LAWS in the CCW. Available from: https://www.un.org/disarmament/the-convention-on-certain-conventional-weapons-/background-on-laws-in-the-ccw [Accessed 24 May 2022].

Velez-Green, A. (2015) The Foreign Policy Essay: The South Korean Sentry—A "Killer Robot" to Prevent War. Available from: https://www.lawfareblog.com/foreign-policy-essay-south-korean-sentry—-killer-robot-prevent-war [Accessed 23 May 2022].

Witschge, L. (2018) Should we be worried about 'killer robots'? Available from: https://www.aljazeera.com/features/2018/4/9/should-we-be-worried-about-killer-robots [Accessed 23 May 2022].

Worldbank, (2020) Fertility rate, total (births per woman). Available from: https://data.worldbank.org/indicator/SP.DYN.TFRT.IN?most_recent_value_desc=false [Accessed 23 May 2022].

Bibliography

Anders, R. (2006) South Korea Intelligent Surveillance and Guard Robot. Available from: https://www.youtube.com/watch?v=pMkV8E2re9U&t=0s

Group of Governmental Experts on Emerging Technologies in the Area of Lethal Autonomous Weapons System. (2019) *Report of the 2019 session of the Group of Governmental Experts on Emerging Technologies in the Area of Lethal Autonomous Weapons Systems.* Geneva: GGE. Available from: https://documents.unoda.org/wp-content/uploads/2020/09/CCW_GGE.1_2019_3_E.pdf [Accessed 9 April 2022]

International Committee of the Red Cross. (2016) *Autonomous Weapon Systems: Implications of Increasing Autonomy in the Critical Functions of Weapons.* Geneva: International Committee of the Red Cross.

Institute of Electrical and Electronics Engineers. (N.D.) Ethical and technical challenges in the development, use, and governance of autonomous weapons systems. Available from: https://standards.ieee.org/wp-content/uploads/import/-documents/other/ethical-technical-challenges-autonomous-weapons-systems.pdf [Accessed 9 April 2022]

Institute of Electrical and Electronics Engineers. (2016) Reframing Autonomous Weapon Systems. Available from: https://standards.ieee.org/wp-content/uploads/import/documents/other/ead_reframing_autonomous_weapons_v2.pdf [Accessed 9 April 2022]

Leys, N. (2018) Autonomous Weapon Systems and International Crises. *Strategic Studies Quarterly* 12(1): 48-73.

Liu, H. Y. (2012) Categorization and Legality of Autonomous and Remote Weapons Systems. *International Review of the Red Cross* 94(886): 627-652.

Lopez, C.T. (2020) DOD Adopts 5 Principles of Artificial Intelligence Ethics. Available from: https://www.defense.gov/News/News-Stories/Article/Article/2094085/dod-adopts-5-principles-of-artificial-intelligence-ethics/ [Accessed 9 April 2022]

Re, A. D. (2017) *Lethal Autonomous Weapons: Take the Human Out of the Loop.* Newport: US Naval War College.

Schmitt, M. N. & Thurnher, J. S. (2013) "Out of the loop": Autonomous Weapon Systems and the Law of Armed Conflict. *Harvard National Security Journal* 4(2): 231-281.

Schaub, G., & Kristoffersen, J. W. (2017) *In, On, or Out of the Loop?: Denmark and Autonomous Weapon Systems.* Copenhagen: Centre for Military Studies.

Tigner, B. (2020) No ‘human-out-of-the-loop' for autonomous weapons, says new European Parliament report. Available from: https://www.janes.com/defence-news/news-detail/no-human-out-of-the-loop-for-autonomous-weapons-says-new-european-parliament-report [Accessed 9 April 2022]