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Final qualification paper

Autonomous Weapon System and Artificial Intelligence: The Problems of Arms Control

Direction 41.04.05 "International Relations"

Master program

BM.5566.2019 "Strategic and Arms Control Studies"

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Saint Petersburg

2021

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Introduction

Arms control of AWS is an emerging issue in the field of international arms control in recent years. One of the reasons is that with the rapid development of AWS and extensive militarization of AI technology, more and more potential risks that will eventually post threats on human beings have appeared. Although AWS brings many advantages that may greatly increase military power, risk and challenges at the ethic and humanitarian level and the impact on international security cannot be neglected.

Since 2013, attention of the international community has been attracted to the emergence of AWS and problems of its arms control. In 2014, the parties held dialogues at the United Nations, and the whole dialogue has been conducted within the framework of the Convention on Conventional Weapons (CCW). The informal dialogue evolved into formal negotiations in 2017, involving more than 70 countries and many scientists and non-governmental organizations. Even though there are issues that slow down the process of setting control during the years, more and more countries have realized that the need is urgent, and the are ready to achieve more actual results. From the current development of the technology and possible scenario that might occur in the coming future, it is possible on the technical level and necessary for the international community to push forward the arms control negotiations of autonomous weapons systems. The "Eleven Guiding Principles"[1] is one of the remarkable results in recent years, which shows the determination of the international community to push forward the process of AWS arms control.

Since the technology has caught everyone's attention, the term "Lethal Autonomous Weapon System (LAWS)" has been used in many researches and articles, while in my research I use the term "Autonomous Weapon System." Depending on how it will serve the purposes, the word lethal deserves more discussion. The AWS does not have to be lethal. Although there are discussions about "killer robots" is in many contexts, the discussion of how to control and regulate is also within the frame of many study. It is very questionable to consider AWS and AI technology as evil and homicidal technology. There is nothing wrong with the technology itself. It is the user and the way to use it that creates the problem. The designers construct the input and process international law and other normative data into the machine. At the same time, at what level should AI be trained before it can be put on the battlefield has also caught attention. These are the new points of the

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[1] Annex IV, Report of the 2019 session of the Group of Governmental Experts on Emerging Technologies in the Area of Lethal Autonomous Weapons Systems, CCW/GGE.1/2019/3, https://undocs.org/en/CCW/GGE.1/2019/3;

problem. In order to avoid misleading in my research, I decided to use the term "Autonomous weapon system" instead of "Lethal Autonomous weapon system."

Development and deployment of AWSs is known as the 'the third revolution in the warfare.' And it will be necessary to establish a proper rule to regulate the military use of AI and the increasing potential appearance of AWSs in the future. While there are many articles that focus on the technical problem and ethical aspects, international concerns, there is a lack of research in the field of why these are problems and what is happening in the process of setting control. What is the prospects of the solution and what can we expect from the future. AWS has the ability to respond to changes in actual circumstances, which automatic weapon systems do not and can only operate based on human instruction entirely. An automatic weapon system is a step on the way to explore autonomy in the weapon system. This study will focus on autonomous weapon systems instead of automatic weapon systems.

The aim of this research is to find out what are the problem and prospects of setting international control over the further development and use of autonomous weapon systems. To achieve this aim, specific **tasks** have been formulated:

- To understand the advantages and disadvantage within the technical background of the AWS;
- To analysis what will going to happened without international control;
- To indicate the what is the problem and need of international control;

The background of the technology and its trend will provide the answer with the experience from the existing AWS and AI technology and how it serves the military that satisfied countries. However, all coins have two sides. AWS and AI technology have their shortages that can not be overcome in a short period of time, and how these issues were causing the problems in the scope of accountability, humanitarian and ethic level. Despite the fact that problems are arising from the development of the technology, with the extensive range of application and high exception from countries that AWS will become a game-changer in the future, AWS and AI technology will have negative impacts on strategic stability and international security. Therefore it is necessity to control the development and deployment of AWS in the future. Although only ethical motivations alone are not enough to push the arms control of AWS into reality, already there is progress. CCW as a main platform and will continue to be in the future, there were conferences for years and only very few progress have been made. A breakthrough happened in 2019 when participants for the first time,

reached an "Eleven Guiding Principles", which is a signal that arms control AWS is possible and it could become a good start for the future process.

The literatures are divided into different groups. One group is about the technical issues like the technical problem[2] and technical feasibility of "the meaningful human control.[3]" There are studies of the barriers and obstacles from the development of technical aspects and the timeline of the capabilities and improvements. Moreover, evaluating the values and purpose of the weapon is also included.

The second group points out some different kinds of global concerns as well as in the terms of generally problem and perspective of AWS. The first part[4] would more focus on the international approach to the problem. The development and deployment of the AWS is the potential conflict that will create new problems among international environment. Thus, it is important to make an assessment of the current interaction and approach to control. The second[5] part of the group put more emphasis on the issues and perspectives. Despite the fact that the autonomous would bring lots of advantages, there are already challenges[6] seems to be serious issues and arouse the attention. The concern not only from the use[7] of it, but also from the way how the civil[8] society response to such technology. The purpose of such weapon will reflect the potential issue[9] it may cause.

Another part of this group[10] is related to the security study. These literatures usually point out the current situation in military and strategic and security problem[11]. The global security always

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[2]Toward the Agile and Comprehensive International Governance of AI and Robotics, Wendell Wallach, Gray Marchant, 2019, Proceeding go the IEEE, Vol 107, No 3;

[3] Taming Killer Robots: Giving Meaning to the "Meaningful Human Control Standard for Lethal Autonomous Weapon Systems", Adam Cook 2019, Judge Advocate General's School, Air University Press ;

[4] Debating Autonomous Weapon System, Their Ethics, and Their Regulation Under International Law, Kenneth Anderson, Matthew C. Waxman, 2017, Columbia Public Law Research Paper No.14-553, Oxford University Press;

[5] D6. 2 Guidelines on Regulating Robotics, Fiorella Battaglia, Antonio Carnevale, Huma Shah, 2014, RoboLaw ;

[6] Deciding on Appropriate Use of Force: Human-machine Interaction in Weapons Systems and Emerging Norms, Hendrik Huelss, 2019, University of Kent, Global policy ;

[7] Intra-Mission: Reflections on Autonomy and Trust between Humans and Machines in Combat, Manabrata Guha, 2019, Workshop on Trusted Autonomous Systems in Defense, University of Oxford, UK

[8] "People are Averse to Machines Making Moral Decisions", Yochanan E Bigman, Krut Gray, 2018, In press, Cognition 181

[9] The next arms race? A military ethical reflection on the effects of artificial superintelligence on drone warfare and American counterterrorism, Gabriel Boulianne Gobeil, 2015

[10] "Killer Robots" and Preventive Arms Control: 2016, The Routledge Handbook of Security Studies, 2nd Edition, pp. 457-468.

[11]Autonomous Weapon Systems, the Frame Problem and Computer Security, Michal Klicewicz, 2015, Journal of Military Ethics, Volume 14 - Issue(2), Published by Routlege

changes with the ongoing situation like the increasing development of AWS is one of the factors. The uncertainty of AWS will have an impact on the strategic stability[12]. This type of the literature[13] normal focuses on the way how technology changes would have an impact on the future warfare[14].

The use of AWS represents a new era in warfare more than other innovations had previously. AWS could be another asset in the military toolbox to replace human soldiers and decision makers under certain circumstances. Thus it raises not only concerns and questions, but also expectations and perspectives. It is necessary for us to confront as far in advance as possible, which could help us to prepare for the future. Therefore the literature[15] with the prediction and expectation of the AWS gives valuable ideas and recommendations for the possible solution and use of the autonomous weapon system. Besides, it is very interesting to see that some authors[16] like to make comparisons between nuclear weapons and AWS. To learn from the previous experience, similarity and difference between them would be useful.

Although from different aspects they provided the opinions that would help to understand the risk and potential of the system more comprehensively separately, the gap between the wish for using the AWS ideally and meet so much difficulty in setting practical control remains. Therefore my study presents what cause and possibility to bridge the gap. Thus this is the academic novelty of this study.

AWS as the frontier technology of modern science and technology is a typical representative of the military application of artificial intelligence. AI accelerates the development of autonomous weapons systems while the core technology of AWS is artificial intelligence. Because of the basic function of the AWS, the development and deployment of the AWS must be based on mature AI technology. As a branch of the artificial intelligence, the AWS and AI are closely connected together. Moreover, in recent years, the significant advancement of AI will cause major innovation

[12] Greg Allen and Taniel Chan , "Artificial Intelligence and National Security", Brief center study, 2017;

[13] Algorithmic Bias and the Principle of Distinction: Towards an Audit of Lethal Autonomous Weapons Systems, Sarah Shoker, 2019, Digitization and Challenge to Democracy Globalization Working Papers;

[14] The Future of War: Could Lethal Autonomous Weapons Make Conflict More Ethical? Steven Umbrello, 2019;

[15] Regulating a Game Changer: Using a Distributed Approach to Develop an Accountability Framework for Lethal Autonomous Weapon Systems, T Krupiy, 2018, Georgetown Journal of International Law ;

[16] Artificial intelligence: A Revolution in Strategic Affairs, Kenneth Payne, 2018, Journal Survival Global Politics and Strategy, Volume 60 - Issue(5) // How viable is international arms control for military artificial intelligence> three lesson from nuclear weapons, Matthijs Maas, 2019 // The impact of artificial intelligence on strategic stability and nuclear risk, Vincent Boulanin, 2019, sipri

and change of the war praxis through AWS directed by artificial intelligence.[17] During discussions in an expert meeting hold by the International Committee of the Red Cross(ICRC) in 2014, speakers and participants referred to the concept of 'fully autonomous weapon systems' meaning highly sophisticated weapon systems with 'artificial intelligence' that are programmed to independently determine their actions, make complex decisions and adapt to their environment.[18] The application of AI in military aspects and weapons has greatly improved the military efficiency of weapons, and conventional weapons can obtain unprecedented "autonomy" through the application platform of AWS. Thus it is necessary to put AWS and AI together in the study.

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[17] Problematic Issue if Autonomous Weapon System in term of International Law of Weaponry and Politics, Bülent YAZICI, 2019, Bilecik Şeyh Edebali University Journal of Social Sciences Institute, DOİ: 10.33905/bseusbed.557220

[18] ICRC, Autonomous weapons systems: Technical, Military, Legal and Humanitarian aspects, Experts meeting, (Geneva, Switzerland, 2014), https://reliefweb.int/sites/reliefweb.int/files/resources/4221-002-autonomous-weapons-systems-full-report%20%281%29.pdf;

Chapter 1. Applying artificial intelligence for the development of autonomous weapon system

1.1. The development of the technologies

The background of the development of the AWS technology has a long history. This subchapter is devoted to find out firstly, how the level of autonomy in the weapon system is evaluate has three main categories: which is Human in the loop, Human on the loop and human out of loop. Secondly, what differences do AWSs bring to the modern combatants?

1.1.1. The development of the autonomy in weapon system

What were the forerunners of the real fully AWSs? There are already many weapons with autonomous functions. For example, missiles can already identify, select and attack targets on their own. Unmanned submarines can find bombs on their own. And drones can form networks of swarm and perform certain tasks independently.

There are three dimensions to understand autonomy in weapon system. Firstly, the relationship between the human and the machine. Secondly, the degree of intelligence of the machine. And the third dimension which is undoubtedly the most important one, is which tasks the AWSs is performing.[19] From the perspective of human-machine relationship, the Observe-Orient-Decide-Act loop is one of the most important processes in the system. The OODA loop is an important decision-making method used in modern military system[20] proposed by John Boyd who is a former U.S. Air Force colonel. "Observe" means the use of sensing equipment and networks to collect relevant information, including information on early warning, their location and status. "Orient" means the analysis and interpretation of the intelligence in order to evaluate the current situation. "Decide" refers to develop an action plan based on the orientation message. "Act" means taking action based on decisions and plans made.[21] With the development of technology, the connotation and extension of OODA ring have been enriched, which has brought about new changes in the relationship between weapons and equipment and people.

Based on the relationship between human and machine in the weapon system, it can be divided into the following three categories according to the role of the part that human participated in the

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[19] Paul Scharre, Presentation at the United Nations Convention on Certain Conventional Weapons, 2015, https://www.unog.ch/80256EDD006B8954/(httpAssets)/98B8F054634E0C7EC1257E2F005759B0/$file/Scharre+presentation+text.pdf

[20] OODA Loop: What is it and how can it be used? Toolshero, 2017, https://www.toolshero.com/decision-making/ooda-loop/;

[21] P.W.Singer, Wired for War: The Robotics Revolution and Conflict in the 21st Century; December 2019; Penguin Books;

process of decision-making, which are "Human in the loop" that known as semi-autonomous weapons system, "Human on the loop," that known as a supervised autonomous weapon system and "Human out of the loop," that known as a fully autonomous weapon system.

Human in the loop means the semi-automated weapon systems can be used to search for targets and instantly transmit target information to human operators. Humans are responsible for making decisions and play a central role decision part and action part in the OODA loop, which systems cannot participate, but waiting for human instructions. However there are disadvantages, this kind of semi-automated weapon systems can be interfered by weather and mostly electronic signals. For example, communication systems of MQ-9 Reaper drone can be interfered by electronic interference signals.[22] Under the currently technical background, the semi-automated weapon systems presented the situation of the most of the AWSs.

Human on the loop stand for the supervised autonomous weapon system, which means that once the system is being launched, the AWSs will be able to observe, orient, decide and act autonomously. The whole process will be supervised by human in case tricky situation happen like the decision of killing. And the system can only operating within the assigned mission. The shortage of the supervised autonomous weapon system is that the search is always not comprehensively and there is the risk of malfunctioning. At present, the general trend in civilian robotics is towards supervised autonomy, where robotic systems are increasingly autonomous while human operators retain oversight and often the ability to intervene.[23] With advances in detection technology and algorithms, more and more semi-automated weapon systems is progressively developing in supervised autonomous weapon system.

Human out of the loop which shows the processes of the autonomy in weapon system. A fully autonomous weapon system can independently complete the whole loop of observation, orientation, decision and action. Fully autonomous weapon systems can adjust their strategies to learn or operate at any time, depending on the differences of the environment. When the system receives an issued target, it transforms it into a task directly that does not require interaction with humans. Throughout this process, humans can hardly intervene. Facing the harsh environmental conditions, the enhancement of autonomy in the weapon system has become a new trend of development.

[22] Minnie Chan, What could China do to hit back at a US drone attack? South China Morning Post, October 2020, Military China, https://www.scmp.com/news/china/military/article/3103827/what-could-china-do-hit-back-us-drone-attack;

[23] ICRC, "Views of the ICRC on autonomous weapon systems, in paper submitted to the Convention on Certain Conventional Weapons Meeting of Experts on Lethal Autonomous Weapons Systems", April 11, 2016, p.1, https://www.icrc.org/en/document/views-icrc-autonomous-weapon-system;

Although humans can enter the loop in the situation of an emergency or a change in targets, there are problems such as a long delay[24]. Fully autonomous weapons are theoretically still in the research and have not yet been actually deployed. There are many human-in-the-loop, a few human-on-the-loop and no human-out-of-the-loop systems in use. Unmanned (automated) systems – they are either in-the-loop or on-the-loop which are currently being developed and deployed by several nations including the United States, Israel, South Korea, Britain, France, Germany, Denmark, Sweden, China, and India.[25]

According to the intelligence level of the machine, the autonomous system can be divided into automatic, automated and autonomous. Which is similar to the OODA loop based category. Automated systems are simple, threshold - based systems that rarely involve decision-making processes, such as old-fashioned thermostats. An automated system is a rule-based system that is more complex than an automated system. More input conditions and weighing variables would be taken into consideration, such as a modern digital programmable thermostat. Autonomous system is a complex system with higher level of intelligence, goal-oriented self-guidance and internal mechanism difficult to be mastered by users. In addition, after defining the concept of autonomy, it is necessary to quantify and measure the degree of autonomy of autonomous weapons, and formulate corresponding rules according to different degrees. Regarding to this the US Office of Naval Research and The Air Force Research Laboratory have defined 10 Autonomous Control levels[26] from remote Control to fully Autonomous clusters, which provide a relatively quantitative measure of the degree of autonomy of drones. This attempt is worth of reference by the international community.

1.1.2. Changes bought by AWSs to combatants

With the explosive growth of big data, more and more the significant improvement of computing power and the progress of deep learning algorithms started can be realized. AI after experiencing some ups and downs, has ushered in the new wave of development, which is deeply affecting the economic, political, military, social and other fields of all countries. The development of the AWS not only evolved the weapon system, but also bring new opportunities to combatants.

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[24] Bradan T.Thomas, Autonomous weapon systems:the anatomy of autonomy and the legality of lethality, Houston Journal of International Law.2014,37(1):243.

[25] Sparrow, R. (2009b) 'Building a Better WarBot: Ethical Issues in the Design of Unmanned Systems for Military Applications', *Science and Engineering Ethics* 15(2): 169–87.

[26] Autonomy Levels for Unmanned Systems (ALFUS) Framework, Volume I: Terminology, National Institute of Standards and Technology, NIST Special Publication 1011, https://www.nist.gov/system/files/documents/el/isd/ks/NISTSP_1011_ver_1-1.pdf;

The AWSs can stay in the field operating autonomously longer than human soldiers and can withstand other obstacles such as acceleration and reducing unnecessary casualties. Benefits of AWSs that relate to improving force protection, reducing procurement costs, and replacing humans in dull and dirty tasks are being valued.[27] Thus saving human combatants from dangerous field and avoid the unnecessary injuries and suffering.

AWSs are able to avoid certain human weaknesses, and do not act out of retaliation, panic, anger, contempt, prejudice or fear. Nor do they intentionally harm civilian populations. Replacing human power with AWSs could help reduce civilian and military casualties in international peacekeeping missions. Reducing mistake and promote the efficiency of human combatants.

The potential of AI for industrial transformation and military revolution is sought after by many people, who believe that AWS will profoundly change the way of military operation. In the futurist Ray Kurzweil's books: The Age of Soul Machines and The Singularity Is Near, he imagines a future in which machines will surpass human intelligence and help human to achieve immortality.[28] Although concerns are being expressed that AWSs and AI technology will bring thrests the social, security, legal, ethical and existence of human, it seems does not influence the good prospects from nations

Despite the face that there are concerns for AWSs, AWSs already showed its potential advantages in military operation. The autonomous way of AWSs in the battle field would minimize the involvement of human, thus greatly reduce in the casualties.

1.2 The application of autonomous weapon system in military domain

At present, the development of AWSs is accelerating towards more diversification and intelligence. There is no doubt that the country which is the first to develop AWS and have the system under its control, will occupy an advantageous position in the world's new military revolution. This subchapter will analysis the use of AWSs in the military domain. Study the experience from it and find out the perspectives of countries plan for the future of AWSs.

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[27] Drs. Jai Galliott & Austin Wyatt, Risks and Benefits of Autonomous Weapon Systems: Perceptions among Future Australian Defence Force Officers, Journal of Indo-Pacific Affairs, Air University Press, November 2020, https://www.airuniversity.af.edu/JIPA/Display/Article/2425657/risks-and-benefits-of-autonomous-weapon-systems-perceptions-among-future-austra/;

[28] Ray Kurzweil, The Singularity is Near: When Humans Transcend Biology, New York: Viking Adult, 2005; Ray Kurzweil, The Age of Spiritual Machines: When Computers Exceed Human Intelligence, Viking Adult, 1999.

1.2.1. Evaluation of existing system and experience

The Hs-293 missiles developed by Germany during World War II were the first guided anti-ship missiles. It presented a kind of semi-automated weapon systems. Germany successfully destroyed the Italian cruiser Rome with its Fritz X missile. Though accurate, they required the delivery aircraft to stay on the same line of sight as the weapon and target; the resultant flight paths were predictable and highly vulnerable, and the Allies quickly developed effective defenses.[29] Nevertheless, It has the ability to search and strike targets automatically to a certain degree. FritzX even can be the first radio-controlled drone. The early guided weapons were mainly guided by radio and radar, and the main targets were industrial facilities, ships, Bridges, arsenals and so on.

And later there were the use of defensive SARMO (Sense and React to Military Objects): once activated, the weapons systems will operate automatically when in function. Such SARMO (Sense and React to Military Objects) weapon systems intercept high-speed inanimate objects such as incoming missiles, artillery shells and mortar grenades automatically. Examples include C-RAM, Phalanx, NBS Mantis and Iron Dome.[30] Lockheed & MIDDOT; Martin's AGM-158C is a long-range anti-ship missile that uses input from onboard sensors to automatically locate and strike targets at sea. All the detection, evaluation and response process will be done within couple second. The operation ability of these AWSs had been greatly improved.

After World War II, the United States vigorously supported and took the lead in the research and development of AWS. In the Vietnam battlefield in the 1970s, the United States successfully used laser-guided "smart bombs" to strike enemy targets for the first time in the war. Meanwhile, it deployed unmanned reconnaissance unmanned aircraft to conduct intelligence shooting and collecting within a certain range through remote control, using unique advantages of AWSs. Nowadays, in the recent controversy surrounding the use of armed unmanned aerial vehicles these frictions have already become clearly visible – even while, in this example, the leveraging of technologies and practices of automation and robotization as well as data science and machine learning for military purposes is only its infancy.[31]

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[29] Stephen Oliver Fought, Rocket and missile system weapon system, Britannica, https://www.britannica.com/technology/rocket-and-missile-system

[30] Noel Sharkey, Towards a principle for the human supervisory control of robot weapons, 2014, University of Sheffield, UK, https://www.unog.ch/80256EDD006B8954/(httpAssets)/2002471923EBF52AC1257CCC0047C791/$file/Article_Sharkey_PrincipleforHumanSupervisory.pdf

[31] Autonomy in Weapon Systems: The Military Application of Artificial Intelligence as a Litmus Test for Germany's New Foreign and Security Policy, A Report by Daniele Amoroso, Frank Sauer, Noel Sharkey, Lucy Suchman and Guglielmo Tamburrini, Edited by the Heinrich Böll Foundation, PUBLICATION SERIES ON DEMOCRACY, VOLUME 49

In 1980, the United States the approach defense systems. The system uses a high-performance computer for a series of program settings, with features such as rapid fire, computer control, radar guidance and other characteristics, but is preset to "only participate in aiming at the target within the defense point and within the predetermined speed range". And without the ability to treat the target differently. It can be said that these early AWSs are mainly used to identify and strike targets according to pre-set procedures. The advantages of automation and unmanned reduce the direct participation of personnel, but the selection and decision-making process is still completely dependent on human beings. The degree of autonomy and the ability to deal with problems are at a low level. These are considered to be the first generation of theAWSs.

AI accelerates the development of AWS. Since the beginning of the 21st century, with the rapid development of AI and the increasingly severe international security situation, intelligent unmanned combat system, is considered as a "talisman" and "assassin's mace" to maintain national security, has gradually moved towards to the realistic battlefield. Breakthroughs in key technologies such as intelligent simulation, accurate identification, deep learning, and big data processing have helped autonomous weapon systems take a leap forward. Since 2002, the United States began to use drones and traditional air strikes to conduct secret targeted clearance operations on the Yemen battlefield. In November 2002, U.S. Predator drones precisely hunted down Al Qaeda leader Abu Ali and five other militants in the eastern part of Sana'a, and drones have become a standing weapon on the US anti-terrorist battlefield since then.

In 2006, South Korea has made progress in armed intelligent robots and deploying them in the demilitarized zone on the border between North Korea and South Korea. It is a SGR-1 machine gun robot designed by Samsung, equipped with heat and motion detectors, which can identify potential targets 2 miles away and perform automatic tracking and positioning of targets. It is equipped with a 5.5mm machine gun and a 40mm grenade launcher that can be fired with human authorization. In July 2013, the X-47B unmanned aerial vehicle developed by Northrop Grumman of the United States created the history of "the first autonomous aircraft catapulted from the deck of an aircraft carrier". And it laid the technical foundation for the US Military's subsequent "ship-borne Unmanned aerial Refueling System" program. Moreover, Israel's Iron Dome defense system, already being deployed can automatically detect missile attacks and fire defensive missiles. All these weapons systems have one thing in common: the ability to spontaneously identify and strike targets.

In 2014, after the United States proposed the "third offset" strategy, the Center for Strategic and Budgetary Assessments (CSBA) proposed the idea of a Global Surveillance and Strike (GSS)

network concept, to deepen and continue the core idea of air-sea Battle. The U.S. military and the defense industry have already made significant achievements in the design, manufacture, operation, and maintenance of complex weapon systems and the idea of "systems of systems" architectures. Such competitiveness requires an extensive and deep technical understanding and years of experience that adversaries will not be able to replicate in the short term. The US can take advantage of this by combining geographically dispersed platforms, such as long-endurance drones, long-range stealth fighters and underwater systems to create a global surveillance and strike network.[32]

Intelligent unmanned combat system greatly improves the autonomy of naval equipment. The "Sea Hunter" unmanned anti-submarine warship, which the U.S. tested in May 2016, is about 132 feet long and has a maximum speed of 27 knots. It has the capability to sail continuously at sea for several months without maneuvering. The US media claimed that its submarine hunting capabilities could make it become a "nightmare for enemy submarines." With strong military scientific research capability and rich combat experience, Russia occupies a leading position in the field of unmanned combat vehicles. The Uranium-9 unmanned combat vehicle developed by the Russian National Defense Export Corporation was first revealed in September 2016. Equipped with a variety of sensors, a laser warning system and thermal and optical cameras, it can detect and acquire targets up to four miles away. The operator can either manually operate it in a mobile vehicle within 1.8 miles, or set a predetermined program. These unmanned vehicles have become one of the hands for Russia to participate in the geopolitical game in Syria.

Historically, the AWSs has shown a trend of continuous improvement. The progress of weapon systems has been accompanied by the improvement of autonomy. At present, at least 90 countries now have UAVs, and 16 countries or non-state actors have armed UAVs.[33] The U.S. Nuclear Posture Review released in February 2018 revealed that Russia is developing a "new intercontinental nuclear-powered submarine autonomous torpedo called the Status 6". In addition, Russia is also actively developing smart missiles, drones, unmanned vehicles and military robots.[34]

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[32] LI B H, HOU B C, YU W T, et al. Applications of artificial intelligence in intelligent manufacturing: a review[J]. Frontiers of Information Technology & Electronic Engineering, 2017, 18(1): 86-96.

[33] Paul Scharre, "Killer Robots and Autonomous Weapons with Paul Scharre," Center for A New American Security, https://www.cnas.org/publications/podcast/killer-robots-and-autonomous -weapons-with-paul-scharre.

[34] Boris Egorov, "Rise of the Machines: A Look at Russia's Latest Combat Robots," Russia Beyond, June 6, 2017, https://www.rbth.com/defence/2017/06/06/rise-of-the-machines-a-look-at -russias-latest-combat-robots_777480; and Nikolai Litovkin, "Comrade in Arms': Russia is Developing a Freethinking War Machine," August 9, 2017, https:// www.rbth.com/defence /2017/08/09/comrade-in-arms-russia-is-developing-a-freethinking-war-machine_819686.

Thus it can be seen that the wave of technology triggered by the revolution of AI promotes the development of weapons and equipments toward autonomy and self-processing of a series of behaviors such as detection, identification, tracking and rendezvous. Such AWSs have entered various fields such as sea, land, air, space and many other fields, giving weapons and equipment the authority to solve simple problems. Therefore further reducing the dependence on the number and skill level of operators, and greatly improving operational effectiveness.

1.2.2. Autonomous weapon system and artificial intelligence as temptation to states

As long as the general trend of technological progress does not change, AI will have an impact and change the existing process of international relations, and the strategic relations among international actors will also have to go through all the significant changes.[35] One of the significant features that AI technology brings to AWSs is the ability of autonomy which distinguishes them from other weapons. Recently, autonomy has been identified by the United States as a cornerstone of its military modernization program. As China also shows the determination become a leading in the field of Artificial Intelligence. A turning point in the articulation of the vision behind this vast network was the publication in July 2017 of the New Generation Artificial Intelligence Development Plan by the Chinese Government.[36] Thus it is can be seem that there will be more development of AI in the future. And it will bring the improvement of the AWSs.

Countries with the capability to produce and develop AWSs will take the strategic vantage point in the future, and AWSs will stand at the strategic commanding heights of future military competitions. AWSs can bring extra operational driving force. Autonomy in the weapon system can increase the speed, accuracy, and durability of weapon systems on the battlefield, as well as extend their strike range and cooperation. Its powerful autonomy without manual operation makes AWSs more intelligent. AWSs plays a similar role in the battlefield. The application of AWSs will reduce the human cost of operations, which undoubtedly brings a huge military driving force to the countries with poor populations and not so rich in resources. Unlike the first industrial revolution, population size will become less important for national power in times of the fourth industrial revolution.

In pursuit of the leading position in the new round of military competition, major powers are scrambling to formulate relevant strategies and policies to encourage the research and development

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[35] Kareem Ayoub and Kenneth Payne，"Strategy in the Age of Artificial Intelligence".

[36] Chinese State Council, 'New Generation Artificial Intelligence Development Plan', Order no. 35, 8 July 2017.

of their own autonomous weapon systems, therefore enhance the militarization of AI in order to occupy the commanding heights of the new military revolution in the world. The new technology that is being developed now is likely to make the fully AWSs become a reality. The potential military value of AI is a huge temptation for many countries. At present, countries around the world especially with huge military power are promoting the militarization of AI openly or secretly. For example, As early as the birth of AI technology, the United States has paid full attention to the application of such technology in the military field.[37] One of the main reasons behind is that the artificial intelligence has great military application prospects in intelligence analysis, command and control, network operations, military logistics, and other fields. The artificial intelligence can significantly improve the traditional weapons systems in an autonomous way, and the high autonomy means the use of the machine can achieve calculation and response speed far exceeding that of humans. For the great powers, this is the strategic technology to preempt the heights of the future military. For smaller countries, they are also strategic technologies and weapons that promise to change the rules of the game of war. For terrorists, this is even more a "godsend" for carrying out terrorist activities.

Although there are many debates regarding AWSs, the combat performance of AWSs has undeniable military advantages from a technical point of view. Known as "battle robot", AWS can reduce the number of combatants for the country, and achieve the intergenerational surmount ability of traditional weapons and equipment. This provides a new strategic idea for countries that bear the pressure of resources and population internally and facing threats from security externally. For example, Japan and Israel with highly advanced technology sectors and unique demographic challenges, may have more interest in developing AWS systems. The invisibility of the strategic upper hand and the great powers with technology developing well and repid are likely to allow more and more AWS systems to emerge quietly.

Besides, it can overcome many the physical limitations of a human soldier. Not only can work tirelessly, but also can overcome the heavy losses and casualties. Besides, there are no psychological problems such as loyalty and bravery of human soldiers. For larger weapons systems like fighters and ships, the response of an autonomous weapon system is more sensitive, rapid, stable and active. Comparing to manual operations, it also had a wider range of the scope. This

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37 AllanM.Din，ed.，ArmsandArtificialIntelligence:WeaponandArmsControlApplicationsofAd- vanced Computing; Jeffrey L. Caton，"Autonomous Weapons Systems: A Brief Survey of Developmental，Opera- tional，Legal and Ethical Issues"，Strategic Studies Institute，U. S. Army War College，December 2015，http: / / www. strategicstudiesinstitute. army. mil / pdffiles / PUB1309. Pdf.

transformation is so qualitatively different from previous military technological innovations that some call it the third weapons revolution after gunpowder and nuclear weapons.

The application of AI in the military field will have an undeniable important impact on intelligence analysis, mission planning, command and decision-making, combat maneuvering, strikes. And promote the entire process of obtaining, transmitting, analyzing, making decisions and operating tasks on the battlefield to be more autonomous and faster. The application level of AI in the military field will become an important symbol of the military strength competition among major powers, and the discourse for the use of AWSs and military intelligence will be increasingly fierce.

1.3. Problems that arise from the development of autonomous weapon system

Although AWS have many advantages, there are many problems that can not be ignored. Development of the technology is a long process that need resources and time to solve problems. This subchapter is devoted to analysis the shortages within the technology what will have influence the reliability during the operation.

1.3.1. Technical shortage of autonomous weapon system

The behavior of the AWSs is hardly predictable, not to mention the high possibility of several AWS function together and how they will react to each other. The battle environment and the military operation is chaotic and complex, in which the AWS must be able to function properly. Adjustments of the enemy forces, poor communications, environmental unpredictability, civilians on the battlefield, cyber attacks, malfunctions, and the "friction" of wars, all of which that indicate to the potential for AWSs to face unexpected circumstances and act in unplanned ways. Because they lack more background information and common sense of human, they are not comparable to humans. And even relatively complex algorithms can go wrong if they are confronted with situations that exceed predetermined design parameters. It is already difficult to foresee all small failures or sudden behaviors that may occur after the system is put into operation, and the complexity of modern computers makes this problem more complicated.

The nature of the computer technology decided there are always a little uncertainty within the algorithm. The core technology of the autonomous weapon system is artificial intelligence, which the limitation and problem will influence each other. Therefore, the limitations of artificial intelligence will constitute the weakness of the autonomous weapon system. Generally speaking, it can be divided into two aspects: internal limitations and external limitations.

In terms of internal limitations, different from traditional information technology, AI has extremely high complexity and is more likely to cause uncertainty and unpredictability. Specifically, AI suffers from the inherent flaw of an "algorithm black box", which its mechanism is difficult to fully understand for the people and operators and the consequences are more difficult to predict. On one hand, it is difficult to eliminate system failure caused by self-interaction and human-computer interaction of the system. When different schemes and system combinations or the interaction between the system and code is too fast, such risks may be highly increased. On the other hand, external limitations mainly come from network attacks, such as the vulnerability caused by enemy hackers and data poisoning. AWSs relies on the computer software and systems therefore they are vulnerable to cyber-attacks, causing disability or even turn against the host on the battlefield.

Even if the AWSs acts autonomously, the concepts "malfunction"is always a possibility of the machine. Because of lack of the same broad contextual intelligence and common sense as humans, even relatively complex algorithms will fail if they are confronted with conditions that beyond the expected design parameters. Once a failure occurs, the high-precision attack capability and differentiation capability of the weapons system will be lost. Not to mention the problem of being hacked, intelligent robots are supported by information technology, it is not ruled out that they will be hacked in some cases. If a robot is controlled by a hacker from an enemy country, it is very likely to turn its guns and to war against its own people. This is the "double-edged sword" of such intelligence. If countries ignore security protection while developing intelligent equipment, they are undoubtedly training "hatchet men" for the enemy.

One day in the future once the fully autonomous weapon systems are activated, the attack selection of theAWSs in the preset algorithm programming will be completely autonomous, and it will autonomously select the attack target according to the target characteristics in the algorithm independently. In the face of the complex battlefield environment, the attack mode of autonomous weapons is relatively rigid. If an attack object that meets the characteristics of the target is in a nuclear power plant, then the AWSs cannot make a value analysis. This is caused by the lack of the "consciousness of judgment" of natural characteristics of AWS. Additional Protocol I stipulates that attacks "shall be strictly limited to military targets" and shall not be attacked on projects or materials containing dangerous forces, such as nuclear power stations, even if such objects are military targets.[38] Currently AWSs find it hard to solve the this judgement problem. The lack of value judgment for AWSs is the a potential reason for unnecessary conflicts.

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[38] Protocol Additional to the Geneva Conventions, Article 52, Paragraph 2

Is it really possible for autonomous weapon system to reach the perfect level of making judgement? There are countless situation and different expectation. Since human can hardly facing all the challenge successfully, how the machine will behavior remains question. At the current stage of AI technology the function that used in identifying targets, still facing technical difficulties. Which greatly decrease the reliability of the AWSs. AWS and AI technology cannot overcome the issue of "Black-box" in a short period of time. Thus it will always have the possibility of malfunction. Causing AWSs lost the advantages from AI

1.3.1. Who should care responsibility for consequence?

Considering that AWS must be preprogrammed by human in advance, thus human plays an important role during the whole operation process. AWS can hardly make self-judgment and choice yet. Can AWS and AI take responsibility of its own action? If the answer is no, then the subject of the responsibility should be the maker to the user? AWS themselves cannot actually bear the legal responsibility for their violation of international humanitarian law, which is also the essential difference between AWS and the traditional combatants, so it is easy to absence of responsibility. It can be seen that if AWS are positioned as combatants, they will cause a great "hidden responsibility".

The problems remain: who should responsible for these behavior? AWSs created a dilemma of "Accountability Gap," in which no party can be held accountable for the unexpected consequences of autonomous weapons. For example, if a military officer accidentally injures civilians by using the AWS that he chose to aim for targets in the battle, causing commit a crime that violates the laws of war or international humanitarian law. Should the responsibility go with the commander, the operator or the program designer? If this is not intentional by the operator, but an unintended accident caused by the failure of the machine to act according to the operator's intentions, it makes accountability more difficult. In addition, AWSs may give all parties an excuse to "pass the buck", since there are multiple groups of people behind it and each person is only a small part of the "accident". As a result, people's feelings of guilt may be diluted, and each person has a reason to avoid responsibility.

And the issue of whether and how to pursue the responsibility of the machine is controversial. If the legal responsibility of the machine should be pursued, it means that the machine is given the status of a legal person, which will cause the ethical issues of whether a machine is considered to be a human. Therefore another problem has emerged. Could the machine become a moral agent? The machine is an object to human as tools or an intelligence agent? In terms of this, the main

disagreement is about the relationship between man and machine. Generally speaking, it can be roughly divided into two schools: "Mere Tools" and "Intelligent Agents". Experts who hold the opinion of "Mere Tool theory", believe that machines, no matter how well developed the machine is, it is only a tool in the hands of humans, but differs in complexity and precision. It is difficult for robots to have moral reasoning and judgment ability and not to mention the self-consciousness. Considering the current research on human self-consciousness is far from clear, the uniqueness of self-consciousness of human beings cannot be replicated in machines in a short period of time. Although autonomous technology will continue to develop, autonomous systems are machines essentially and can only operate on the instructions programmed in advance by humans. Based on this, it is not rational to   believe that machines will have the capability to make life or death decisions some time in the future, because the only people could responsible for the use of force are commanders, operators, programmers, and engineers. Machines cannot be held responsibility.

On the other hand, according to "Intelligent Agents theory" experts, autonomous technologies may evolve into an independent agents and break through from human control eventually. In particular, robots may have the ability of judgment and decision making as a human, which directly challenging human ethics and dignity. It is a major ethical issue to give the power of the decision making of human life and death to machines. Hence it is necessary to regulate autonomous weapon system, such as embedding elements like human values, ethical standards into the machine. In the [34] 2016 conference, some delegates proposed the concept of a "intelligent partnership" between human and machine, which is used to describe a scenarios which machines provide data to facilitate human decision-making procedures. It has also been pointed out that people can become the "weak link" in the system when they have little time to consider the reasonableness of the advice provided by the machines or "overly trusting" the machines.[35]

One possible solution is that responsibility should follow the chain of command and it is necessary to make it clear that organizations or individuals that using weapon systems with varying degrees of autonomy should be responsible for their actions**RRR**; "System failure" is not a justification for unnecessary death or injury.

1.3.2 Analysis of Authorities

Since the AWS is based on AI which is a man made weapon ,it is very important to manage specific people in terms of the need of tactics, techniques and procedures. No doubt there would be many people involved in the whole process.

The person from the process of the development of the system should be taken into consideration. A complicated system like AWS require cooperation with people. And all the individuals has different charges. There would be many potential relevant people: "the software programmer, hardware make, military commander in charge of the operation, the military personnel that sent the AWS into action or those overseeing its operation, the individual(s) who conducted the weapons review, or political leaders."[39] As well as relevant scientists and technical experts, manufacturers and even ordinary people. Although most of the problem would related to the technology and algorithm itself and no one is actually push the fire button, there is always responsibility. This potential list only provided human that might be involved, on the contrary with many people on the call list the responsibility might be decreased because everyone will just keep blaming each other. Thus by listing people of responsibility doesn't help effectively regulate the behavior neither the AWS nor human.

While researching and developing AWS, designers should coordinate the comparison and clarify the rights and obligations of all parties. For the current stage of the AWS, one of the urgent regulations are the clarification of the rights and obligations of AI and robotics experts to legally develop and manufacture robots. And specify that government decision makers must undertake internal audit obligations for the rapidly developing military applications of artificial intelligence. If it is uncertain whether it will be difficult to restrict once put into practice, a "prior prohibition" should be take into consideration.

Force commanders, combatants and etc are likely primary users of such weapons. Although in accordance with international criminal law, in most cases human operators do not have to bear the responsibility for weapon injuries, if human operators have known in advance the hazards and risks of the use of autonomous weapons systems, they must be responsible for the negative consequences of autonomous action. For the general public, the development of such weapons system that are not under human control will not only trigger a "global artificial intelligence arms race", but also have unpredictable consequences. If this concept and approach is incorporated into international humanitarian law and international human rights law, which currently only governs human actors and not machines, these international laws may provide an adequate basis for the regulation of autonomous weapons systems. For non-autonomous weapons, the "human" control factors are in the chain of command, so the corresponding "human" whether the developer, manufacturer, or user will have to bear the corresponding responsibility.

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[39] Wagner, Markus, Autonomous Weapon Systems (January 1, 2016). Max Planck Encyclopedia of Public International Law, Rüdiger Wolfrum, ed., Oxford University Press, Available at SSRN: https://ssrn.com/abstract=2786136.

At present, it is possible to investigate the human responsibility involved. However if the AWSs is to be fully autonomous in the future, then it would learn from experience and make decisions that reflect the results of learning. In this way, it might be even harder for designers to predict and control. Thus result in an even more tricky situation trying to find the specific people responsible for the consequences. Therefore before there are better solutions, the action of AWS should taken into account as a national behavior.

1.3.2. Meaningful Human Control

AWS and AI technology are full of prospects, especially AI technology can promote the establishment and improvement of strategic decision-making assistance system. The example of AlphaGo's defeated Go champion Ke Jie can successfully demonstrated that artificial intelligence has an advantage that humans can hardly match in game projects with the characteristics of "complete information game". In other "incomplete information games" such as Texas Hold 'em, the advantages of AI in strategy decision are even more obvious. Therefore, how to ensure that artificial intelligence does not lose control in the process of serving human has become an important topic.

The idea of "meaningful human control" attracted everyone's attention. It is refers to the ability of humans to regulate and restrict the ability to operate independently of weapon technology systems, which including the control of time, place and way to control the use of force. It is a method that make the AWS legal and acceptable to the various parameters, rather than the means of autonomy are defined.[40] However some delegations from the CCW questioned the definition, saying that it was too vague and subjective to prevent unintended consequences, since human control was vulnerable to external circumstances, particularly under the circumstances of coercion. Other experts advocate to the use of concept of "human judgement." At the meeting in 2016, some delegations once again emphasized on the concept of "human control" as the framework for assessing legal, moral and ethical issues in the evaluation of AWSs. And some suggested that "human control" should be considered in the different stages of the use of AWSs, such as weapon selection, weapon deployment, target selection and attack. However, criticized pointed that the subjectivity of the concept and the difficulty in determining its scope remains, arguing the concept of "human control" should be replaced by the concept "human judgement"

In the traditional form of war, weapon is being controlled with the concept of tool. However with the development of the AWS system, the relations between human and weapon will be changed. Human in a dominant position while machine providing assistance is the first relation. Human and

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[40] CCW, Report of the 2015 Informal Meeting of Experts on Lethal Autonomous Weapons System

machine are cooperating and working together is the second relation, which is the most important and the trends for the future. However in the meantime it is should be aware that with the increasing autonomy in the weapon system without control, one day the AWSs might break through the control from human and bring aftermath that is unpredictable.

It is a general opinion that when facing the decision of using forces, it is important to remain the human sense of judgment within the process especially in the situation of killing and damage. It has attracted many attention that human's dignity can not be violated by machine, which machine cannot decided the live and die of human. If human cannot make decision on the at what level of autonomy in the weapon system should be controlled, the AWS evolve into an unstoppable dangerous monster that harm combatants and civilians without control.

ICRC pointed out that "erase human as a main body on lethal decision is a damage to the human society".[41] This is the moment when machine not only an object belongs to human, but also a subject that relatively equal to human ethically or legally. The war will transform into a way that instead of human, machine will be combatants. Thus the question of should the authorization of "shot to kill" be handed to machine, is focused on Yes and No. Meaningful human control is being appealed by many nations and experts. At present, maybe the only way to avoid potential risk is always remain human in the chain of machine process.

Overall, no matter how powerful a weapon is, the weapon is always the object to human. Instead of keep rapid development of technology, In the ear of AI and advanced technology, deal with the changing relation between human and machine is a way to make the weapon even more power. The meaningful human control in the AWSs not only means the control from human to machine, but also keep the human in a dominant position within the weapon system, which is a possible way to prevent machine from completely out of control.

Chapter one helps us to learn that the AWS is a representative of the militarization of AI. The AWS is already existed and have been deployed by many countries. The current deploy experience shows that the use of AWS will bring many beneficial. On the positive side, AWS in the military field can bring many positive effects, including improving operation efficiency, reducing the pressure of officers and soldiers physically and cognitively, reducing the burden of the decision support system, reducing the cost, fighting within the prescribed scope of moral operations, providing a realistic comprehensive training, expanding the breadth and depth of operations,

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[41] ICRC, "Views of the ICRC on autonomous weapon systems, in paper submitted to the Convention on Certain Conventional Weapons Meeting of Experts on Lethal Autonomous Weapons Systems", April 11, 2016, p.1, https://www.icrc.org/en/document/views-icrc-autonomous-weapon-system

meeting faster combat rhythm and so on the unique advantages that distinguish it from a conventional weapon system. The advancement of technology becomes a new military power, and drives the evolution of new forms of war simultaneously through equipment technology. The satisfied experience from military will increase the willingness of countries to keep using and developing AWS. More and more autonomy will be found in the characteristics of military weapons and systems. In the future war, the operative field and combat capability of AWS will continue to improve with the upgrading of technology. In the future war, the combatants will not only be the operators of AWS, but also the leaders in intelligent confrontations. The use of AWS poses a significant challenge to the attribution of responsibility for the use of force. The technology itself have problems like "Black Box" that cannot be overcome in a short period of time. That even all the programming and operator doesn't make any mistake. There is still the possible that the machine could go malfunctioning. One fact that could not be denied is that users would found it hard to fully trust the system. Thus it makes it even more important to maintain meaningful human control within the whole process. Although internationally it has not reach an agreement currently, meaningful human control is the at least a doable and realistic way for human to prevent machine form compete out of control which has already been approved by many countries.

Chapter 2. Bitter truth behind the surface - threats and challenges posting by autonomous weapon system

2.1. Autonomous weapon system into reality, the devil or the hero?

Is it appropriate to apply the principles of International Humanitarian Law and the Laws of War to the application of AWS and AI technology? Whether their regulations can be applied remain to be discussed. For example, the "Principle of distinguishment" that distinguish military and civilian targets from being attacked, the "Principle of Proportionality" that prohibits excessive attacks, the "principle of military necessity" which includes the restrictions on the means of warfare. In this subchapter, analysis will be make to study what challenge will appear from the International Humanitarian Law and ethical level.

2.1.1. Debates of autonomous weapon system and artificial intelligence under the international humanitarian law

With the continuous development of human civilization, in the process of using force, combats should be constrained by international humanitarian law. Based on the Geneva Conventions and their protocols, International humanitarian law is supplemented by a series of relevant specific legal instruments and international customary law, which aims to limit the harm of war and armed conflict from the humanitarian perspective. AWSs would face great, if not insurmountable, difficulties in reliably distinguishing between lawful and unlawful targets as required by international humanitarian law.[42] The rule of distinction is required under both Additional Protocol I to the Geneva Conventions and under customary international law. The following three aspects are most closely relevant to the principles of international humanitarian law. There are the principles of distinguishment, principle of proportionality and Martens Clause.

Firstly, weather is was compliance with the principles of "distinguishment". This principle requires that in order to ensure respect for and protection of the civilian population and civilian objects, the Parties to the conflict shall at all times distinguish between the civilian population and combatants and between civilian objects and military objectives and accordingly shall direct their operations only against military objectives.[43] For machines, distinguishing people is undoubtedly

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[42] Additional Protocol, International Committee of the Red Cross (ICRC), *Customary International Humanitarian Law Database*, https://ihl-databases.icrc.org/customary-ihl/eng/docs/v1_rul_rule1;

[43] ICRC, the principle of distinguishment Article 48, INTERNATIONAL LAW IN ARMED CONFLICT, Sweden, Report of the Swedish International Humanitarian Law Committee; https://ihl-databases.icrc.org/applic/ihl/ihl.nsf/Article.xsp?action=openDocument&documentId=8A9E7E14C63C7F30C12563CD0051DC5C;

the most difficult. Especially in urban combat, it is difficult to judge whether the target is a combatant only through the behavior of the target, rather than through clothing, equipment, and other marks. AWS inability to understand thoughts and emotions can also become an important obstacle to compliance with the principle of "distinguishment".

At present AI has achieved a lower error rate than human in image recognition, but this is only limited to meaningful objects in the real world, such as faces, plants, etc.[44] The problem is that AI always recognize meaningless images as real-world objects. For example, AI could recognize an imagine as an object. This misjudgment arises mostly from the inherent flaw of AI itself. Black box in computer science means the reason behind a malfunction of program is unknown because of internal processing is unclear. The problem of black box still can not be overcome under the modern science, which make it difficult for humans to accurately predict their behavior by knowing the construction of AI internal logical structure. Hackers often take advantage of this vulnerability to create false data to induce AWSs to attack false targets or seize control of AWSs. For example, embedding patterns on the clothing and equipment of an enemy combatant, or on buildings and facilities that humans can hardly recognize but maybe recognized by machines as high-confidence targets, causing AWSs to attack the wrong target. So under the condition that AI has obvious vulnerabilities and is difficult to defend, AWSs obviously cannot compliance the principle of distinction. Before the issues are resolved, the application of AWSs in the field of military intelligence or a high-risk confrontation environment may incur huge ethical risks.

From the perspective of the so called the third industrial revolution and the continuous improvement of military science and technology, both soldiers and civilians have gradually become victims of weapons. With the establishment of the international humanitarian law system, the regulation of weapons and the protection of civilians have become the focus of international humanitarian law. The technological innovation of AWSs do not make it earlier to obey the principle of distinguishment. This is one of the reasons that the voice of international community that called for more legal regulations on AWS has been more and more put into consideration.

Secondly, whether accord with the principle of proportionality. It requires that an attack be carried out to ensure that the inevitable collateral injury or damage caused to civilians or civilian objects is not excessive in comparison with the intended military benefits, as well as balancing military necessity and humanitarian requirements. Proportionality analyses allows for a "fairly broad margin

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44 He K,Zhang X,Ren S,et al.Deep Residual Learning for Image Recognition[C]// IEEE Conference on Computer Vision & Pattern Recognition.IEEE Computer Society,2016.

of judgment,"[45] but the sort of judgment required in deciding how to weigh civilian harm and military advantage in unanticipated situations would be difficult to replicate in machines. As it does require that such collateral casualties should be reduced as much as possible and limited to a minimum.[46] According to the International Committee of the Red Cross (ICRC), judgments about whether a particular attack is proportionate "must above all be a question of common sense and good faith," characteristics that many would agree machines cannot possess, however thorough their programming.[47] While the procedural system can be continuously improved to evolve the assessment of the degree of civilian casualties, seeking optimal solutions to minimize civilian casualties through precise fire control systems and damaging range calculations and other high-tech tools, the core of the principle of proportionality is to assess military necessity and ensure that the military benefits should not significantly exceed the collateral damage caused. This is not a simple quantitative calculation, but a case-by-case judgment that needs to be made in a complex environment based on unforeseen circumstances. The measurement and trade off between humanitarian protection and military necessity is a value judgment, not a decision that can be made through quantitative analysis, which is precisely a task that artificial intelligence is difficult to accomplish.

On one hand, the rules measure whether the deployment of AWS is necessary and conducive to victory. From the perspective of social costs, the economic cost of deploying AWS is much less than the cost of human combatants. From the perspective of combat effectiveness, physical limitations and mental stress will also affect the accuracy of human combatants' decision-making. From the perspective of moral cost, scholars who supported the development of AWS, for example Nibelin, believed that the deployment of AWS did not have the moral pressure of casualties and could reduce the psychological trauma of human combatants in the war.[48] AWSs will not be affected by emotions and could use algorithms to attack the target in a relatively ethical way in a dynamic environment based one the range of firepower and target characteristics. People like Peter Asaro argued that "The necessity of respecting the value of human life applies not only to the judgment of collateral

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[45] ICRC, Commentary of 1987 on the Protocol Additional to the Geneva Conventions of 12 August 1949, and Relating to the Protection of Victims of International Armed Conflicts (Protocol I), adopted 8 June 1977, https://ihl-databases.icrc.org/applic/ihl/ihl.nsf/Comment.xsp?action=openDocument&documentId=D80D14D84BF36B92C12563CD00434FBD

[46] ICRC, the principle of proportionality Article 51:5(b), INTERNATIONAL LAW IN ARMED CONFLICT, Sweden, Report of the Swedish International Humanitarian Law Committee; https://ihl-databases.icrc.org/applic/ihl/ihl.nsf/Article.xsp?action=openDocument&documentId=4BEBD9920AE0AEAEC12563CD0051DC9E;

[47] 47 ICRC, *Commentary of 1987 on Protocol I*, art. 57, para. 2208.

[48] Nibbeling N.The effects of anxiety and exercise-induced fatigue on shooting accuracy and cognitive performance in infantry soldiers[J].Ergonomics,2014,57(9):1366-1379.

damage to civilians, but also to the disposal of enemy lives." Even if AWSs could reduce civilian casualties, they would still be unjustified because they would "violate human dignity in determining human life and death".[49]

On the other hand, the major consideration is whether the level of damage inflicted by AWSs on civilians and human combatants is commensurate with military needs. The ratio of military needs to collateral damage is difficult to determine. And it all depends on the proportion of targets and non-targets in the target area. In places where civilian populations are minimal, such as deserts, space, etc., the collateral damage of AWS is acceptable. When deploying AWSs on the battlefield of densely populated cities, it is necessary to carefully consider the issue of proportions. how many civilian lives are "acceptable" collateral damage when using AWSs? There is no definitive answer yet, and disagreements over so-called proportions will linger. AWSs still have a long way to meet the statutes of just war theory.

The advantage of AWSs lies in the absence of emotions, and the avoidance of the psychological impact of war on human beings, thus avoid tragedy and irrational behavior. The code determines how AWS will act in combat. Thus, in different missions, AWSs could be more suited to military needs than human combatants. However, in when it comes to more complicate tasks such as lethal decision making, the technical characteristics and flaws of the AWSs will bring great uncertainty to the realization of complex military objectives.

The basis goal of all war operations is the elimination of the enemy's military forces. Autonomous weapons have the potential to cause "unnecessary suffering." The existing operational practices of semi-autonomous weapons or autonomous weapons provide some examples. In 2004, more than 4,700 people were killed by 364 U.S. drone strikes in Pakistan. And most of the UAV's attacks on the human body are likely to cause serious physical injury, such as loss of limbs or permanent pain.

Drone attacks will not only cause killings or physical harm. It will also cause serious mental and emotional harm to witnesses and the families of the victims. For example, in Waziristan there are children witnessed their grandmother was blown to pieces in a drone strike[50]. Merely the memory of this trauma continues to cause great emotional distress throughout their adult lives. Unmanned aerial vehicle attacks could cause great tremendous pain in physical and psychological that are completely disproportionate to military goals. Dr Stuart Casey Maslen is responsible for the

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[49] MARY ELLEN O'CONNELL, Banning Autonomous Killing: the legal the ethical requirement that humans make near time lethal decisions, Cornell University Press, 2014, https://www.law.upenn.edu/live/files/3802-oconnell-mary-banning-autonomous-killing-the-legal;

[50] "Will I be next?" US drone strikes in Pakistan, Amnesty International publication, https://www.amnesty.org/download/Documents/12000/asa330132013en.pdf;

weapons laws and non-state armed actors' compliance to international norms. He once pointed out in an international commentary: "Any force used must be no more than the minimum necessary in the circumstances. And the two fundamental principles governing any use of force under the law of law enforcement are necessity and proportionality." [51]

Finally, whether it complies with the "Martens Clause". It is a general principle which since 1907 has been considered to contain features of customary law.[52] It is difficult for any legal rules to foresee the subsequent development of weapon technology, but the principle of humanity could not have been absent. For this reason, the international humanitarian law has established a more than 100 years old principle that any new weapons must abide by the "principle of humanity" and must not violate the "public conscience", even if it is not stated in existing treaties. Any new weapon cannot automatically enjoy legitimacy simply because existing rules of humanitarian law do not prohibit it. The International Court of Justice pointed out in its advisory opinion on the "Legality of the Threat or Use of Nuclear Weapons" that the Martens Clause is an effective way to deal with rapidly evolving military technology. Opponents argue that artificial intelligence weapons face serious moral and ethical concerns and thus pose a huge challenge to the "public conscience". Not to mention that entrusting machines with power over human life and death would not only create huge objective risks, but also trample on human dignity. In addition, public opinion is strongly opposed to the weaponization of artificial intelligence with many scientists and non-governmental organizations calling for a total ban on the development and use of AI technology.

Based on the above standards of international humanitarian law, the international community has launched a fierce interdisciplinary debate on whether the weaponization of artificial intelligence is legal. Supporters believe that AI technology not only meet the requirements of humanitarian law, but also help promote compliance with the law by protecting war victims better and reduce human casualties and economic costs. The opponents argue that artificial intelligence weapons cannot meet the requirements of humanism, especially difficult to comply with the principle of distinguishment and proportionality. AI technology development is still facing a number of serious ethical issues and should be restricted or banned.

Although there is disagreement on whether AWSs and AI technology would comply with international humanitarian law, this does not mean that there is no consensus between the two parties. On one hand the main objection of the opposition is that the critical functions of the

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[51] Stuart Casey Maslen, Legality of Use of Armed Unmanned Systems in Law Enforcement, Chapter 2

[52] ICRC, INTERNATIONAL LAW IN ARMED CONFLICT, Sweden, Report of the Swedish International Humanitarian Law Committee; https://casebook.icrc.org/case-study/sweden-report-swedish-international-humanitarian-law-committee;

weapons are not controlled by humans. But this kind of weapon that is completely out of human control has not yet appeared and it is unpredictable when humans will be able to develop it. Even proponents are not made it clear that they want to develop AWS at fully autonomous level. On the other hand, proponents also agree and recognize that AWSs may have great risks once completely out of human control. Thus both side advocate to improve the reliability of the systems while retaining meaningful human control in order to decrease the humanitarian problems that may cause.

2.1.2. Ethical challenges brought by autonomous weapon system and artificial intelligence

Currently the academic community has proposed two ways to realize the problem of converting ethical rules into machine language to improve the ability of AWSs to response properly in the different circumstances. The first one is the approach transform ethical rules into machine language and code them into programming of AWSs. The second is to make AWSs to learn form experience from differences cases that related to ethic matters.[53] The problem with embedding ethical rules into AWSs is to unify the ethical differences in AWSs and it is difficult for AWSs to understand subtle moral differences. Thus, it is difficult to write codes for the thing that is not objective such as ethical and moral judgement by human.

The ability of AWSs to understand different circumstances was built mainly through making AWSs observe a large number of human actual combat behaviors, strengthening the learning of ethical rules and constructing a value system similar to human's, and then make moral decision.[54] The problem with this approach is that AWSs cannot possibly study every situations on the battlefield. Moreover, the ethical choice of human combatants in extreme situations is mostly an automatic response based on their own ethical values. In other words, observing the decisions of human combatants on battlefield in different situations does not enable AWSs to learn ethical rules properly, but merely general moral preferences. Therefore, in a randomly situation of military practice, the deployment of AWSs will still likely to cause immeasurable ethical risks.

The actual battlefield environment is always far more complex and variable than codes preprogrammed by procedures. For example, assuming that the attack target programmed by the AWS algorithm is a specific type of armored vehicle, even if the algorithm programming recorded the characteristics of the armored vehicle, with many uncertainties and unpredictabilities like single interference or suddenly many armored vehicle showed up with certain characteristics as

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53 Wallach W.Moral machines:teaching robots right from wrong[M].New York:Oxford University Press,2009:16.

54 Batavia P H,Pomerleau D A,Thorpe C E.Applying advanced learning algorithms to alvinn[M].Carnegie Mellon University,The Robotics Institute,1996:27-58.

programming recorded, the AWS could find it difficult to make decision as it is programmed to. Since military operations are now often conducted in civilian residential centers, civilians are also likely to participate in hostilities during wartime. Making it even more difficult to distinguish between civilians and combatants without mistake. The requirements for distinguishing between combatants and civilians are way more above the current capabilities. And sometimes a determination of the intentions of a potential target is necessary, which artificial intelligence in this regard is far from qualified. Not to mention that once a malfunction occurs, most of the advantage capabilities of AWSs will be lost.

Human rights organizations, as well as a growing number of States, have been arguing for banning weapons systems satisfying this condition – that are usually referred to as AWSs in this account – and for maintaining meaningful human control (MHC) over any weapons systems. This twofold goal has been pursued by leveraging on ethical and legal arguments, which spell out a variety of deontological or consequentialist reasons.[55] Consequentialism is a theory that suggests an action is good or bad depending on its outcome. This basic form of consequentialism holds an action as ethical if and only if it produces more beneficial/pleasure-causing outcomes than negative/pain-causing ones.[56] Deontological ethics claims that the right or wrong of an event is determined by its own rules, regardless of the outcome. When analyzing the ethical issues of AWSs, consequentialism focuses on the impact and possibility of AWSs that will bring more killings on battlefield, especially civilian casualties.

The machine without compassion would eliminate the target without being soft heart. The philosopher Michael Walzer's research on empathy and compassion in war has shown that there are many times in human warfare in which one's opponent is spared by pity, a phenomenon known as the "naked soldier" moments.[57] When it comes to AWSs, this phenomenon is likely to disappear because machines and algorithms are programmed to perform programmed tasks rigidly, without any so-called compassion. From this perspective, AWSs may cause more battlefield casualties than

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[55] Daniele Amoroso, Guglielmo Tamburrini, The Ethical and Legal Case Against Autonomy in weapon systems, Global Jurist 17(3), 2017, https://www.researchgate.net/publication/319985172_The_Ethical_and_Legal_Case_Against_Autonomy_in_Weapons_Systems;

[56] Ethics Explainer: Consequentialism; Article Big Thinkers + Explainers; The ethics Centre, February 2016, https://ethics.org.au/ethics-explainer-consequentialism/;

[57] Michael Walzer, Just and Unjust Wars: A Moral Argument with Historical Illustrations, 4th Ed., New York: Basic Books, 1977

ever before. In the book of Paul Scharre, he described an incident that he and his fellow allow a perhaps five or six years old girl that was indicated she was scouting their position for a Taliban force hiding nearby. "My fellow soldiers and I knew killing her would be morally wrong. We did not even discuss it." he said. Under the rules of war, the young girl was an enemy combatant, putting his unit at risk, and so could have been shot. Yet, he chose not to, acting out of an innate moral impulse.[58] Whether it was a hand-to-hand combat in the era of cold weapons, or the use of remotely controlled missiles to destroy enemy bases, AWS remove people from the decision-making chain of targeting and killing, which will reduce or even eliminate people's moral responsibility and psychological guilt that people have when they kill, thus leading to more unconscious killings and casualties.

As the beginning of the next round of industrial revolution, AWSs and AI technology presents a huge possibility to subvert the traditional methods of warfare. The risks and challenges brought by the progress of AI will not only promote the changes on the material level, but also continue to impact people's views.

2.2. Autonomous weapon system and artificial intelligence as an impact on strategic stability and international security

The progress of AI technology will profoundly change the weapon system, military strategy, military organization and even the meaning of warfare. Human society will also step into a completely different military security environment after entering the era of AI.[59] It is recognized that no one can win in a nuclear war and that nuclear weapons may put all mankind in danger of extinction. Nowadays AI will challenge the classic "mutual assured destruction" theory. In 2018, a report by RAND Cooperation "How might artificial intelligence affect the rick of nuclear war" pointed out that by 2040, the advancement in AI technology will greatly increase the possibility of retaliatory nuclear counterattack forces being targeted and destroyed, thus weakening the basis for "mutual assured destruction" and breaking the strategic nuclear balance .[60]

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[58] Review by Michael Klare, Army of None: Autonomous Weapon and the Future of War, by Paul Scharre, 2018, Arms Control association; https://www.armscontrol.org/act/2018-11/book-reviews/army-none-autonomous-weapons-future-war

[59] Vincent Boulanin and Maaike Verbruggen，Mapping the Development of Autonomy in Weapon Systems, SIPRI, November 2017;

[60] Edward Geist, Andrew J. Lohn, How Might Artificial Intelligence Affect the Risk of Nuclear War? RAND Cooperation, 2018, https://www.rand.org/pubs/perspectives/PE296.html;

Technological change has one of the most significant impacts on international politics, and the rapid development of AI has already shown the signal to the next important revolution since the beginning of the 21st century. While it shows the great value on the strategic value nationally, it will also bring an unavoidable impact to the international community. How AWSs and AI technology will have influence on the strategic stability and international security is not only because of the characterize of new technology, but also related to the way how they are being applied for equipment for different purposes.

2.2.1. Artificial intelligence and the rise of nuclear war

From the 21st century B.C., cold weapons such as knives, swords, guns, bows, and arrows were used for combat. From the end of the 20th century until now, the form of war has entered the early stage of information warfare. The weapons and equipment have become automatic command system gradually with emergency of satellite, electronic warfare, unmanned aerial vehicles, and etc., using theory of integrated joint operations to achieve final goal. Today, warfare is developing rapidly through new technologies such as drones and guided missiles, which can launch extremely focused attacks and minimizes casualties.[61]

A fundamental pillar of nuclear deterrence during the cold war was mutually assured destruction between the United States and the USSR: the concept is based on the logic that, as each side maintains nuclear forces that could survive a first strike and inflict retaliatory damage that the aggressor would consider unacceptable.[62] From autonomous nuclear submarines to algorithms detecting a threat, to robot-guided high-speed missiles, artificial intelligence could revolutionize nuclear weapons.[63] The deep involvement of AI technology will bring new variables to the nuclear deterrence model which may significantly destabilize global security architecture.

Data collection and analysis conducted by AI systems could enable precision strikes to destroy key command, control, and communication assets for nuclear forces. It provides a new capability for analysis and create misconceptions which will have a direct impact on the credibility of nuclear deterrence. For example, AI could identify a nuclear submarine on patrol in the ocean, or

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[61] The development of warfare overview, Bitesize, BBC, https://www.bbc.co.uk/bitesize/guides/zfmny4j/revision/3;

[62] Brooks, L., 'Can the United States and Russia reach a joint understanding of the components, prospects and possibilities of strategic stability?', Revitalizing Nuclear Arms Control and Non-Proliferation, International Luxembourg Forum on Preventing Nuclear Catastrophe: Moscow, 2017; http://www.luxembourgforum.org/media/documents/Revitalizing_Nuclear_Arms_Control_and_Non-Proliferation-Moscow-2017.pdf;

[63] Sébastian SEIBT, From the A bomb to the AI bomb, nuclear weapons' problematic evolution, France 24, 2019, https://www.france24.com/en/20190510-nuclear-weapons-artificial-intelligence-ai-missiles-bombs-technology-military;

could interfere with nuclear command and control, thus jeopardizing one, or more, legs of the nuclear triad. In a crisis situation this creates pressure for leaders to use their nuclear weapons before losing control over them.[64]

In the context of big data, subjective factors such as national will and strategic intention that originally had greater uncertainty will be displayed in the form of probability with the deep learning algorithm one way or another. In the ear of weak AI, only the combination of AI technology and nuclear weapon can form an effective deterrence system.[65] The military power gap between actors will be expanded again due to the level of AI technology and AWS, the country's military strategic objectives will be adjusted accordingly. This will make the international system even more unstable.

In comparison, the current impact of AWS on the risk of nuclear war and global strategic stability has attracted relatively little attention and discussion. The reason for this circumstance may be the AI technology and its application, which has not yet reached the degree of complete autonomy, are not enough to shake the strategic stability based on mutual deterrence between existing nuclear powers. The nuclear command and control system, the way of using nuclear weapons and the development level of nuclear forces of most nuclear states are in a state of confidentiality. And the degree as well as method of application of AI in nuclear weapon systems are still in the stage of exploration. Given the massive destructiveness of nuclear weapons and the rapid development of AI, exploring the combination of the two and its impact on strategic stability is valuable for future prospects. Given the example from the Cold War when United States and Soviet Union applied AI technology into different system, it is can be learnt that AI technology has intensified the situation and fasten the development of the technology.

In the 1960s, the U.S. Defense Advanced Research Projects Agency (DARPA) begin to research and develop "Strategic Automated Command and Control System" (SACCS). The system provides critical secure (TS) command control information, such as EAMs, FDMs, situation monitoring, current intelligence, force status, operations monitoring, warnings, strategic replanning and redirection, and damage/strike assessments.[66] The application of AI technology to decision-making assistance in nuclear war by the United States had offset and weakened the strategic advantage

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[64] Jennifer Spindel, Artificial intelligence and nuclear weapons: Bringer of hope or harbinger of doom? European Leadership Network, 2020, https://www.europeanleadershipnetwork.org/commentary/bringer-of-hope-or-harbinger-of-doom-artificial-intelligence-and-nuclear-weapons/;

[65] Greg Allen and Taniel Chan，"Artificial Intelligence and National Security", Brief center study, 2017;

[66] Strategic Automated Command Control System, Federation of American Science, https://fas.org/nuke/guide/usa/c3i/saccs.htm;

gained by the Soviet Union due to intercontinental ballistic missiles and ballistic missile nuclear submarines. In 1985, the Soviet Union also began to consider the application of AI in its nuclear command and control system and developed an automatic nuclear counterattack system called the Dead Hand, which was designed to automate nuclear retaliation when encounter of U.S. nuclear strike.

In order to prevent the other side from launching a surprise attack and to make a "fast, accurate and efficient" nuclear counterattack after the failure of deterrence, the US and the Soviet Union have applied AI technology to the detection and early warning system. As well as command-and-control systems were also applied with AI to shorten decision time and conduct a rapid nuclear counterattack.

The military application of AI technology played an important role in the rapid evolution of the offensive and defensive situation of the United States and the Soviet Union during the Cold War. Although compared with strategic nuclear submarines and intercontinental ballistic missiles, space-based anti-missile technology and other kinds of strategic weapons, the level of development and application were relatively limited, they still caused certain impact on the nuclear war as well as the strategic stability between the United States and the Soviet Union during the Cold War.

2.2.2. Strategic Stability under the ear the autonomous weapon system and artificial intelligence

Intelligent weapons are dangerous weapons. After World War II, weapons of mass destruction, including nuclear weapons, became the "killer" of military powers. So far, only the United States has dropped two small atomic bombs in wars, while nuclear weapons in other countries are basically used for strategic deterrence. Considering once the nuclear-weapon states use nuclear weapons for war, it will bring disastrous consequences to both sides. In addition, nuclear facilities, including warheads, are easily detected by other countries, thus other countries can take precautions. AI research can be carried out either indoors or separately, making it difficult for external forces to effectively detect it. And the lethality of such weapons after they are put on the battlefield can hardly be estimated.

The military application of AI plays its role mainly through AWSs. According to the degree of autonomy, which is determined by the degree of human intervention, AWSs are mainly divided into automatic weapons, remote control weapons, semi-autonomous weapons, and fully autonomous weapons. During the Cold War, the military application of AI between the United States and the Soviet Union was mainly in the stage of automatic weapons. With the "leap-forward" development

of AI technology in the future, the impact of more advanced AWSs on strategic stability may be reflected in the following aspects.

The combination of AWSs and networks can complement each other's strengths. AI systems used in conjunction with existing cyber offense tools might become powerful force multipliers, thus enabling sophisticated cyber attacks to be executed on a larger scale (both geographically and across networks), at faster speeds, simultaneously across multiple military domains, and with greater anonymity than before.[67] On contrary, it will have same effects. AWS can help strengthen the nuclear command and control system's defenses against cyber attacks and cyber interference, as well as its resilience after attacks. In the case of the incapability of the communication satellite, the airborne communication network carried by the high altitude UAV can effectively restore the wartime communication, and the adversary can no longer gain the advantage by preemptively striking the communication satellite. Besides, it can be used to attack nuclear warheads and their delivery vehicles, command and control systems, or infrastructure of hostile countries. By interfering the adversary's system, the more technologically advanced countries gain a huge advantage. Such difference in capabilities within countries may affect negatively to global strategic stability.

AWSs and AI technology may be used for intelligence, surveillance, and reconnaissance systems. With the development of technology, remote sensing systems based on AI technology can be deployed in various extreme environments such as polar, deep sea and oceans. Autonomous surface vessels (ASV), autonomous underwater vehicles (AUV), and autonomous aircraft (AAV) can all be used for intelligence, surveillance, and reconnaissance missions. For countries with advanced AI technology, if this technology is applied to nuclear weapon related the early warning and intelligence reconnaissance and surveillance system, it will help decision makers to better predict and grasp the development and deployment of nuclear weapons of other countries, thus enhancing their confidence in strategic nuclear deterrence and conducive to strategic stability among countries.

However, at the same time AWSs can more accurately and effectively search, track, locate and target the nuclear weapons systems of hostile countries, greatly reducing the nuclear retaliation capabilities of other countries. For example, Underwater drones could make the underwater combat environment more transparent and weaken the deterrence of other countries' sea-based nuclear forces. The "Sea Hunter", an unmanned anti-submarine warship tested by the US in May 2016, is

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[67] JAMES JOHNSON AND ELEANOR KRABILL, AI, CYBERSPACE, AND NUCLEAR WEAPONS, WAR ON THE ROCKS, Texas National Security Review, https://warontherocks.com/2020/01/ai-cyberspace-and-nuclear-weapons/;

capable of operating unmanned at sea for months. It has been described by the US media as "a nightmare for enemy submarines".

Then is used for decision assistance system. If AI technology is widely used in wartime decision-making assistance, it will also bring two influences on the strategic stability of countries: it can actively discover the correlation between different data and make intent and threat judgments on the detected images. "Tactical networks often suffer from intermittent and low-bandwidth connections due to their hostile operation environment," said Dr. Ting He, associate professor at Pennsylvania State University. "In addition, although artificial intelligence techniques have the potential to greatly improve the situational awareness of Soldiers and commanders, to keep them updated about the fast-changing situations, the machine learning models need to be frequently retrained using updated data, which are often distributed across data sources with unreliable or poor connections."[68] Thus conducive to the country's more rapid implementation of nuclear offensive or counterattack operations. On the other hand, when the nuclear war decision-making process and time are greatly shortened, the risk of escalation of conflict between countries caused by accident would greatly increase. In order to avoid being passive, those countries that may encounter nuclear strikes may try to use drones, cyber attacks or other means to destroy or interfere with their nuclear command and control systems in order to gain advantage, thus upgrading the risk of conventional conflict into nuclear conflict.

But in the meantime, fully autonomous weapons systems would make the weapon system to a level that out of human control at some point, making it hard for human to control the automatic escalation of the crisis in time. From this perspective, fully autonomous weapon system reduces the stability. An interesting example is that the Battle happened in New Orleans in 1812, although the peace agreement was signed on December 24, word did not reach the British forces assailing the Gulf coast in time to halt a major attack.[69] Resulting in the innocent death of thousands of soldiers. The leaders and chiefs wanted to end the war but were unable to control the progress of it because of certain reasons. Would a similar tragedy happen in the age of AWS on the battlefield? This is worth pondering. At the same time, the advantages of AWS in speed will accelerate the pace of war and shorten the time of decision-making of human beings. This will easily lead to hasty response in and then unnecessary escalation of circumstances, which will also reduce the stability.

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[68] U.S. Army CCDC Army Research Laboratory Public Affairs， Machine learning algorithms promise better situational awareness, US, Army, 2020, https://www.army.mil/article/236647/machine_learning_algorithms_promise_better_situational_awareness;

[69] The battle of New Orleans, January 08, This day in History, History, https://www.history.com/this-day-in-history/the-battle-of-new-orleans;

To say that statesmen's beliefs about both capabilities and intentions are usually badly flawed is not to say that they are foolish. Rather, errors are inevitable in light of the difficulty of assessing technological and organizational capabilities, the obstacles to inferring others' intentions correctly, the limitations on people's abilities to process information.[70] Psychological biases affect a leader's ability to manage and defuse crises[71] The psychological impact cannot be ignored. The introduction of AWS into warfare is the equivalent to another big uncertainty into the leaders of the two parties of the conflict, which will be difficult to predict and explain in a period of time. The perception of AWS is unpredictable, and this has triggered the vigilance of the leaders of both sides, the enhancing the effectiveness of mutual deterrence, which may result in decrease of strategic stability. However, at the same time it is difficult for machines to understand the possible consequences of its actions and the true intentions of leaders. This could possibly lead to an unacceptable result like fail pull back situation from the brink of war.

Whether AI technology would aggravate or reduce the risk of nuclear war between countries mainly depends on the development degree and application mode of AI technology in nuclear weapon states. Countries with more mature technologies can apply their AWS to nuclear command and control, intelligence, surveillance and reconnaissance, decision-making assistance and other aspects, so that they can better detect and warn adversaries of their nuclear situation, and at the same time launch nuclear retaliation and counterattack more effectively. However the gap between countries will continue to grow and it is hardly to know whether a country apply AWS and AI technology on offensive or defensive system. Distrust between countries will be another reasons that will impact strategic stability.

Under the still complex nuclear background, the negative effect of AWS on global strategic stability will continue to increase. Now, while AWS are still in their early development stages, it is worth the time of policymakers to carefully consider whether the putative operational advantages from AWS are worth the potential risks of instability and escalation they may raise.[72] Although developing AI technology could strengthen strategic deterrence, nuclear-weapon states should

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[70] Robot I. Rotberg and Theodore K. Rabb, The Origin and Prevention of Major Wars, STUDIES IN INTERDISCIPLINARY HISTORY, https://pestuge.iliauni.edu.ge/wp-content/uploads/2017/12/Robert-Jervis-War-and-Misperception.pdf;

[71] Thomas Christensen, Rose Mcdermott, Roundtable 10-4 on Perception and Misperception in International Politics and on How Statesmen Think: The Psychology of International Politics, H-Diplo | ISSF Roundtable, Volume X, No. 4 (2017); https://issforum.org/roundtables/10-4-jervis;

[72] Burgess Laird, The Risks of Autonomous Weapons Systems for Crisis Stability and Conflict Escalation in Future U.S.-Russia Confrontations, Commentary, The Rand Blog, June 2020, https://www.rand.org/blog/2020/06/the-risks-of-autonomous-weapons-systems-for-crisis.html;

actively, proactively, and effectively avoid and control security risks caused by technology abuse and proliferation. Firstly, states should push forward the arms control negotiation agenda on AWS under the framework of the United Nations, conditionally include AWS in new strategic arms control agreements, and prevent a vicious arms race in the field of AWS and AI. Then states can learn from the experience of nuclear weapons control, such as the principle of "No First Use" and clarifying the permissible scope of use of AWS. Especially we should make it clear that we should not actively attack certain targets such as infrastructures.

Unlike previous technological changes, revolution in the field of AI technology will change the military field in all directions. Technological progress will once again enlarge the power gap between military subjects in a short period of time, and side who own such power will be more likely to have the ability to surpass traditional military forces. Therefore, inevitably impact the strategic stability.

2.2.3. Merging of autonomous weapon system with artificial intelligence as a challenge for international security

An arms race in AWS and AI, seems to be already in progress. Take the development of drones as an example, some predict that by 2021 the global drone market will reach US$94 billion by 2021.[38] With the rapid increase of military unmanned equipment, the military application of UAVs will not be limited to the field of counter-terrorism and special missions. And once these weapons are used in the military security interaction between states, the existing form of war and rules of engagement would be rewritten.

More importantly, no one can accurately predict exactly what kind of future the unmanned and intelligent warfare will be. The lower threshold of war, expanding the scale of weapon arsenal, and uncleared technological evolution experience and so on, all of them make the arms race of AWSs likely to become a new source of strategic mistrust among states, especially among the regional countries. At the same time, since the development and military[39] application of artificial intelligence began as early as the 20th century, the proliferation of AWSs is not limited to the systems such as drones and others in the traditional field, but may be spread in various military fields. Scholars warned against this trend: " If AWSs has the opportunity to be developed and deployed, they will settle in every field eventually - air, space, ocean, or land. They will hunt and weave in groups. Into a complex network of unmanned weapon systems".[40]

The impact of AWSs on the balance of power in the international community is shown in at least two aspects. The first is to disrupt the structure of strategic stability. Since the Cold war, one of the important cornerstones of global strategic stability has been the relatively balanced nuclear deterrence among the major powers, which will be influenced by the AWS. With the continuous development of intelligence technology, the characteristics of unmanned weapons and equipment will gradually shift from the current emphasis not only on endurance and low energy consumption, but also the speed and stealth performance and operation.

The rise of drone swarm tactics also provide a new way to break through the defense system.[41] These changes will enable technologically well developed countries to have more powerful attack weapons with greater combat effectiveness and less risk of being destroyed, thus posing a serious challenge to the adversary's strategic deterrence capability. The development of new unmanned weapons means a highly credible threat, since the use of such weapons would be harmless to our personnel but also provides long-range precision strike capabilities that can evade sophisticated air defence systems. [42] The next generation of maneuverability, invisibility, and autonomy of the system may decrease the deterrence and retaliate credibility of a country that originally had the ability to deter. For the same reason, the relatively low cost and long hidden underwater unmanned systems will cause the underwater combat environment more clearly, leading to a greater threat to the submarines which are an important means of nuclear deterrence.[43]

The second influence is on the conventional forces. The resources required for development of AWS are different from that of traditional weapons, and the requirement of technological level is obviously higher than the requirement for conventional forces such as population and traditional energy. Technologically advanced developing countries may be the biggest beneficiaries of the AWS, since the rapid development of this technology means that "military power will gradually become disconnected with the population base, which had been an important measure of military power traditionally". [44] All in all, AWS could bring more uncertainty and instability into the international community, whether by weakening strategic deterrence or rewriting the distribution of conventional power.

Then, AWS may also lead to escalation of conflict. Due to the low cost of using AWS, state actors may be increasingly inclined to use such weapons to detect capabilities, resolution and strategies of their opponents. For example, In one incident in 2012 Hezbollah in Lebanon used an Iranian-made drone to investigate on Israeli nuclear facilities, but was shot down by air power. And in late 2016, the U.S. unmanned submarine also triggered a [45] diplomatic event during reconnaissance in the

South China Sea. Thus, on one hand states have strong motivation to use such weapons to obtain intelligence, situational awareness and even conduct limited offenses. On the other hand, it is not easy for the targeted country of these operations to accurately judge the actual intent of the action. It is possible to mistake the proximity reconnaissance for a pre emptive strike and make the situation even more complicated.

Whether AWS can release clear and unmistakable signals to express their intentions when performing tasks may become a new problem that challenges security interactions between nations. For countries that are in hostile or tense relations, even if the violation of AWS is not conducted itself, it may be interpreted as a serious provocation against national security. And leading to more stringent response measures and unnecessary escalation of the conflict. In addition, AWS is highly dependent on the perception and [46] exchange of information about the external environment, which increases the possibility of accidents and malicious intervention by humans.

Small or not so well developed countries lack the objective technology to develop AWS. From the perspective of military interests, if autonomous weapons are allowed to be put on the battlefield in the future, small and medium developing countries will directly face a battle with autonomous robots. They will compete with countries that military is well developed. The gap will further widen and deepen, and the wars with countries that use AWS will constitute an asymmetric war. In the future, the application of autonomous weapons on the battlefield will become difficult to prevent under the dominance of major powers.

When AWS and AI technologies are applied to international security, it will add new destabilizing factors to the international system. Currently in the process of AWS and AI technology, although the application of new technologies in the military field is not mature and some research is still at its beginning stage, AI has been considered as an important auxiliary tool for participants in international political activities in the fields of strategic decision making assistance systems and intelligent military systems. And with the improvement of the technical level, the technological generation gap in this field will have an irreversible impact on the international security.

Therefore, from chapter two it is clear that here are many problems when it comes to the obligations of IHL, currently there are a lot of foreseeable problems that will become a huge problem in the future if there is no control and no regulation. Since "virtuous robots" with ethical programs that ensure compliance with IHL obligations are not yet (and may never be) a reality, it appears that the use of autonomous combatants in armed conflicts in the foreseeable future will

have to be subject to carefully designed operational constraints based on their capabilities. Deployment without control is unimaginable and will bring disaster to human society.

AWS can negatively impact on strategic stability. Since the cold war, one of the key cornerstones of strategic stability has been the nuclear deterrent among the countries. With the continuous development of AWS and AI, technology might provide a new way to break through the system with less risky and more effective methods. Thus posing a serious challenge to their adversaries' strategic capabilities. Not to mention the system itself may produce misjudgment, which can easily lead to strategic misjudgment and undermine strategic stability.

The great temptation from the foreseeable benefits from such technology would unavoidably intensify the arms race, leading escalation and instability of conflicts. The requirement of AWS will focus on the technology rather than the requirements for population and resources, which bring opportunity to medium countries with advanced technology. In the meantime the big countries will become even more powerful and not well developed countries will be in an even more worth situation. The increasing gap between countries will influence global security. Therefore it is necessity to set international arms control on AWSs before the world slip into a dangerous situation that seriously challenging humanitarian and human rights, and posing a threat to civilians. As well as posting threaten to strategic stability.

Chapter 3. International control is needed and there is a long way to go

Since attention has been caught by AWSs, there were calls for a total ban and ams control. Currently there are approach to set control on AWSs. However the there are only few progresses. This chapter will analysis why the process of setting international arms control on AWSs is slow and difficult. What are reasons behind the problem and what prospects can be expected.

3.1. Proliferation of autonomous weapon system is possible and needed to be wary

The risk of militarization of artificial intelligence continues to emerge. The founder of Tesla, Elon Musk, has intent to compare the development of general artificial intelligence as "calling the devil", reminding people to be wary of the potential threats of artificial intelligence to mankind. And said that competing for the advantage of artificial intelligence development may lead to the third world war.[3] Well-known scientists and technical experts have realized the problem and have repeatedly called for the international community to aware of dangerous process, especially the development and deployment of AWS systems. While AI has offered solutions to many problems and increased efficiency to transportation and health care etc., many questions will come up sooner or later once the systems are weaponized and operate autonomously especially without human intervention. This has already caught attention that a group of well-known scientists issued a joint open letter calling for the development of reliable and beneficial artificial intelligence.[4]

The military use of artificial intelligence and algorithms has the potential of causing misunderstanding and fallacies. The current artificial intelligence has a relatively reliable ability to mark and classify limited objects, such as furniture, plants and animals. However, when it comes to training artificial intelligence to understand more complex phenomena, it may lead to completely wrong results because of limited data and technology. There are many problems in the application of automatic face recognition. For example, according to the MIT study, point out that the facial recognition algorithms designed by tech giants like IBM and Microsoft could come up with different results given the same control group. The study found that the error rate of light-skinned men and dark-skinned women is as high as 35% in the process of detection. What's more, there are other studies that support the biased conclusions of artificial intelligence identification, especially with a huge amount of data when the parameters can hardly involved all encompassing in the programming that make it more fluid and dynamic. The action plan suggested by AI is mostly based on cognitive foundation, and the foundation itself already has the potential of being biased. Just imagine how serious the consequences would be if it were applied to the battlefield and some wrongly identified targets were attacked by mistake.

AWS is attractive to non-state actors such as terrorist organizations and transnational criminal groups, giving them the ability to strengthen the power of their forces, saving their own fighters while launching more terrorist attacks. Alvin Wilby who is vice president of research at French defense giant Thales, once said that rogue states and terrorists "it will not be long before evil groups are in possession of lethal artificial intelligence (AI)."[73] Concerning is spreading that there is the possibility that the "copy" of the technology and weapon could fall into the hands of rogue groups in the future. Thus the possibility of non-State actors and particularly terrorist groups, might acquire and use such weapons is another important reason for concern about the safety of AWS. Meanwhile, the current generation of drones can already operate remotely or even autonomously partly to complete the strike mission, which seems to match well with the violent behavior pattern favored by extremists. As a result, the research and development of AI and AWS may exacerbate the threat of terrorism. British counter-terrorism experts have warned that terrorists may use drones to attack a civilian aircraft.[74]

In April 2017, the US military proposed the MAVEN project to create the Algorithmic Warfare Cross Functional Team to focus on applying AI to defense intelligence gathering and analysis.[75] The task is to help the US Department of Defense process and analyze massive amounts of video data from all over the world. The Ministry of National Defense also turned to seek cooperation with academics and industry AI experts such as Google, which is one of the best in the field of AI research and development. Researchers believe that AI technology could cause major negligence in an undetectable way, and cause fatal consequences. Thus there was increasingly concerns. On April 4, 2018, 3,100 Google employees jointly issued an open letter requesting Google to withdraw from the MAVEN project led by the US Department of Defense. Google promising all employees that they would never participate in any plans or projects that intend to create similar war technology.

Meanwhile, the development of AWS is relatively secretive. Any lab with the capability of AI and big data processing technology can build a fairly AWS within a certain amount of time. Commercial companies use social economies and free markets to help infiltrate AWS and robotics technologies from the civilian sector, increasing the difficulty of supervision and verification of the arms control of this weapon system. Due to the dual-use nature of AI technology, many AWS originally used for

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[73] Sean Martin, AI terror warning: Death cults such as ISIS 'Certain to get their hands on killer robots', Express, December 2017, https://www.express.co.uk/news/science/887978/ISIS-terror-groups-artificial-intelligence-terminator-killer-robot-thales-AI;

[74] Doug Bolton, "Terrorists Could Use Drones to Attack Planes and Spread Propaganda, Government Security Adviser Warns," *Independent*, December 6, 2015;

[75] 75 Robert Work, "Establishment of an Algorithmic Warfare Cross-Functional Team (Project Maven) ," April 26, 2017, https://www.govexec.com/media/gbc/docs/pdfs_edit/establishment_of_the_ awcft_project_maven.pdf.

civilian purposes can easily be converted into military systems, which would undoubtedly facilitate proliferation. In 2018, fifty-seven scientists from 29 countries have called for a boycott of a top South Korean university because of a new center aimed at using artificial intelligence (AI) to bolster national security, which is the action of Korea Advanced Institute of Science and Technology operated jointly with South Korean defense company Hanwha Systems with the purpose of developing AI-based command and decision systems.[76] In announcing the boycott, the AI scientists said they were disappointed the Korea Advanced Institute of Science and Technology (KAIST) was looking "to accelerate the arms race to develop such weapons,"[77] Since nonproliferation policies may target relatively few aspects regarding to AWS for now, the system is likely to be used by more state and non-state actors, which will bring side effects on arms control.

With the continuous advancement of AI technology, its application in the military field has become more and more extensive. Unmanned aerial vehicles, unmanned combat vehicles, unmanned ships, unmanned submarines and so on are emerging in large numbers, as well

as the level of intelligence and autonomy is getting higher and higher. Although these weapons have been developed to minimize the threat to human lives in military conflicts, imagine what it would   be like if the dangerous actors used these weapons to carry out mass destruction. Some people claim that the stage of robotic and intelligent warfare has already begun, which has aroused great concern   among scientists and researchers. The development of AWS by South Korean scientific research institutions that can search and eliminate targets under unmanned control has become a representative direction of the current progress in the   militarization of artificial intelligence. There will not be much doubt if the autonomous weapon systems join future wars.

3.1.1. Necessity of setting control

Advanced technology will bring unexpected consequences while the development of the technology is unstoppable. What can be foreseen is merely a corner of the potential outcome. Because of nations all have their own mind, there are problems with approaches to setting control while it is necessarily. International community had been putting efforts for years and there are results. From the perspectives of recent years, the future of AWS and AI arms control maybe not promising, but positive.

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[76] Matthew Huston, South Korean university's AI work for defense contractor draws boycott, Science, April 2018, https://www.sciencemag.org/news/2018/04/korean-university-s-ai-work-defense-contractor-draws-boycott;

[77] Ben Westcott, "Scientists call for boycott of South Korean university over killer robot fears," CNN, 5 April 2018. https://www.cnn.com/2018/04/05/asia/ai-weapons-killer-robots-boycottintl/index.html;

It is undeniable that as a new means of combating armed conflict, the form of conflict has been transformed from the traditional "frontal struggle between humans" to "survival contest between humans and robots". Especially when conflict side would hardly have without any cost except the economic cost, armed conflict will be more inclined to unilateral killing that beyond all ethical constraints.[78] Since a complete ban on AWS is almost impossible, it must be heavily regulated and constrained.

First of all, standardize the research and development. At present, most world leaders and military experts of various countries have realized that if the AWS is completely out of the human control, it will eventually harm human or even human themselves will become the target of machines. Therefore, no matter at what stage of development, the human control should always be retained in the crucial decisions such as life and death. If possible, it is best to set up ethical review standards, standardize algorithm progresses and legalize programming behaviors at the beginning of the design of the program. Since April 2014, the German government issued a position statement on AWS that it is "indispensable to maintain meaningful human control over the decision to kill another human being."[79], and that it is dangerous to abandon human intervention in the selection of targets and participation in the process. Later, France and Japan also announced that they were not seeking to develop fully autonomous weapons systems, but to increase the degree of automation rather than autonomy of the military's armed forces, so as to increase the efficiency of precision strikes and speed up response when deploying these weapons. Now this general notion, gaining prominence in the wake of the call for "meaningful human control" originally introduced by the NGO Article 36,[80] is being embraced by civil society as well as a consistently growing number of CCW States Parties.

None of these systems are designed to kill people in combat, but there is an element of "automation bias" that results in a delegation of responsibility for decisions to a computer and the result is that decision support is allowed to become decision making by default[81]. So how to avoid such incidents from happening and how to define "key parts" and "control functions" that can only control by humans, there are currently no strict implementation standards in the academic and

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[78] Jack M.Beard, "Autonomous Weapons and Human Rsponsibilities", in *Georgetown Journal of International Law*, 2014; https://digitalcommons.unl.edu/cgi/viewcontent.cgi?article=1196&context=lawfacpub;

[79] Government of Germany, Statement to the Convention on Conventional Weapons informal meeting of experts on lethal autonomous weapons systems, May 13, 2014, https://www.unog.ch/80256EDD006B8954/(httpAssets)/9FB02F665072E11AC1257CD70066D830/$file/Germany+LAWS+2014.pdf;

[80] Richard Moyes, "Key Elements of Meaningful Human Control", Article 36, April 2016, www.article36.org/wp-content/uploads/2016/04/MHC-2016-FINAL.pdf;

[81] Gregory P. Noone and Diana C. Noone, "The Debate Over Autonomous Weapons Systems", in Case Western Reserve Journal of International Law,Vol.47, No.1, 2015;

policy circles. While there is different terminology, "Control" is stronger than alternatives such as "intervention" and "judgment" and is broad enough to encompass both of them; it is also a familiar concept in international law.[82]

The existing concerns and discussions involve the following review elements. Firstly, the optimal time interval between human decision making and machine decision making should be considered. Secondly, to limit the deployment environment of the machine, especially to fully confirm whether there are civilians within the environment. Last but not least is to establish executable standards to evaluate the quality of machine operators such as designer and the skill of operator.

Take victims of the Ukraine International Airlines flight 752 plane disaster as an example, Iran's Revolutionary Guards shot down the Ukraine International Airlines flight on Jan. 8, 2020 shortly after it took off from Tehran Airport. The Iranian government later declared that the shooting-down was a "disastrous mistake" by forces who were on high alert during a regional confrontation with the United States.[83] Had only very limited to make decision, the operator mistaken the plane for missile. The point here is not to excuse this tragedy but to highlight the almost impossible demands that such a timeframe represents for critical deliberation in high stress combat scenarios.[84]

Measures should be taken to limit deployment. While CCW states parties have agreed that international humanitarian law applies to this new technology, there are debates about how it does.[85] Since AWS are currently unable to distinguish between combatants and innocent civilians, and it can hardly judge whether combatants have already put down their weapons and if it is a fake surrendering. The deployment of such weapons for military purpose and automatic duty should be strictly limited in the areas where there is almost no presence of human being such as sea or desert environment. And should not be in a complex environment such as cities and towns where there are always crowds and activities of people. In particular, the use of AWS in human living areas, or the activation of autonomous decision-making functions of weapon systems for whatever military

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[82] 1 Campaign to Stop Killer Robots, "Key Elements of a Treaty on Fully Autonomous Weapons: Frequently Asked Questions";

[83] Reuters Staff, Iran's final report blames air defence operator error for Ukraine plane crash, AEROSPACE AND DEFENSE, March 2021, https://www.reuters.com/article/us-iran-crash-ukraine-idUSKBN2B92CL;

[84] https://thebulletin.org/2021/04/worried-about-the-autonomous-weapons-of-the-future-look-at-whats-already-gone-wrong/

[85] The applicability of international humanitarian law to lethal autonomous weapons systems is the first of 11 guiding principles adopted by CCW states parties. "Report of the 2018 Session of the Group of Governmental Experts on Emerging Technologies in the Area of Lethal Autonomous Weapons Systems," CCW/GGE.1/2018/3, October 23, 2018, https://www.unog.ch/80256EDD006B8954/(httpAssets)/20092911F6495FA7C125830E003F9A5B/$file/CCW_GGE.1_2018_3_final.pdf;

purpose, should be completely prohibited in order to avoid indiscriminate harm to innocent civilians.

In addition, the deployment of AWS should be limited to specific military tasks with a defensive characteristic, such as intelligence collection, surveillance and rescue and other peace-building activities or non-aggressive behaviors. And should not include those machines and systems that have the possibility to miscalculate and misjudge thus cause misfire and accidental injury. Error within the unmanned aerial vehicle algorithm may cause accidental bombing and manslaughter and may also cause the machine to kill in the so-called name of justice, especially if the machine relies on autonomous decision-making to execute for justices. This is an action of depriving the suspect of a fair trial and the legal right to prove innocence even the target is a real crime. It is likely to cause the terrorist situation of "machine tyranny" which everyone will be target and hunting by machines at any time. No doubt it will be a chaos globally.

In general, with the advancement and maturity of AWS and AI technology, certain critical functions in weapons systems are capable of operating autonomously. This trend towards gradually increasing autonomy in military systems in general and, in particular, in weapons system will continue in the future.[86]

Christoph Hynes's recommendations to the United Nations on the Report of the Special Rapporteur point out that "The Human Rights Council should call on all States to declare and implement national moratoria on at least the testing, production, assembly, transfer, acquisition, deployment and use of Lethal autonomous robotics until such time as an internationally agreed upon framework on the future of Lethal autonomous robotics has been established".[87] Establishing the necessary regulatory framework to limit or regulate the deployment of AWS should be a one of the priority.

Many countries are not willing to do it. One of the potential reasons behind it is that AWS is essentially a set of software program, easy to develop, spread, obtain with not too difficult accessibility. If the country doesn't have enough practical methods to completely prevent people to develop such technology privately, the banning would equally to encouraging people to research and develop secretly and thus led to an even more worse black market transaction. The concealment and disorder of such weapons and technology would be bring more risk of losing control.

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[86] Lethal Autonomous Weapons Systems Technology, Definition, Ethics, Law & Security, Federal Foreign Office, https://www.auswaertiges-amt.de/blob/610608/5f26c2e0826db0d000072441fdeaa8ba/abruestung-laws-data.pdf;

[87] Christof Heyns, Report of the Special Rapporteur on extrajudicial, summary or arbitrary executions, Promotion and protection of all human rights, civil, political, economic, social and cultural rights, including the right to development, Agenda item 3, Twenty-third session, Human Rights Council, General Assembly, United Nations, April 2013, https://www.ohchr.org/Documents/HRBodies/HRCouncil/RegularSession/Session23/A-HRC-23-47_en.pdf;

Undoubtedly, in the era of AI, AWS and drones will be more and more widely used in various combat scenarios. The future of human society may depend more and more on whether AWS can be controlled through technical programming and regulatory constraints. However, judging from the current technological progress, AWS programming as a human product, there is no sense of human at any level. Ethics is defined in accordance with algorithm rules. The behavior of machine only a reflection of algorithm rather than the human moral judgment. Thus, when conduct an attack, the machine will only consider the conformity of the feature and accuracy of attacking. It does not consider whether the person being attacked is a true enemy, nor does to verify whether the person being attacked is innocent.

In general, in the absence of moral judgment and legal regulations, AWS and the designer behind it currently will hardly consider the consequences of an action. At the same time, it is not difficult to escape from the social justice of offensive behavior. In the absence of such matters, the emergence of AWS would bring potential harm to human society if without restrained and supervised.

Recognizing these risks and discussion got under way, it became clear that the majority of governments still agree that human control is necessary over critical functions of weapon systems, such as those related to selecting and "engaging"—firing upon—targets.[88] Robots are human manufactures and accessories and should not be self-governing and separated from human control. The battle and conflicts between robots have created a technological possibility for human beings to officially withdraw from the arena of violence which people had to shed blood to defend the safety of life and property in the part. Now all this is about to be replaced by the confrontation between robots. But it also increases invisible violence, it will also impact the future of national security.

Many AWS and AI technology in military were initially designed to meet the needs of special combat environments. some systems will be designed only for use in operational environments in which there are few if any civilians present—an attack against an undersea submarine, for example. The naval ship-borne, automated anti-missile systems described above are usually used in environments with few civilians present.[89] Other use of AWS such as small portable mobile robots, which can serve as Itinerant scouts in place of human soldiers to protect the combat personnel from the threat of attack in dangerous environments. For example, The MTGR EOD (Micro Tactical

[88] Ray Acheson, "It's Time to Exercise Human Control over the CCW," Reaching Critical Will's CCW Report, vol. 7, no. 2, March 27, 2019, https://reachingcriticalwill.org/images/documents/Disarmament-fora/ccw/2019/gge/reports/CCWR7.2.pdf;

[89] Kenneth Anderson and Matthew P. Waxman, "Law and Ethics for Autonomous Weapon Systems: Why a Ban Won't Work and How the Laws of War Can", American University, WCL Research Paper 2013-11,Columbia Public Law Research Paper 13-351 (2013),http://papers.ssrn.com/sol3/papers.cfm?abstract_id=2250126;

Ground Robot Explosive Ordnance Disposal) system is designed to assist units around the world by engaging explosives and dangerous substances, which can be used for route clearing, IEDs, checkpoints and vehicle inspections.[90] Under this circumstance, every robot that entered the repair shop is a life saver.

For these AWS and AI technologies, the reason why the current criticism is relatively less is that these weapons system are not aimed at innocents or civilians. However, this does not mean that all AWS and AI technology in the future will be legal or ethical. Assuming a possible future conflict scenario: both two rival nations have deployed a large number of AWS, and there is a small provoke. With common sense of human judgments, it would stay in a form of small conflict. But with autonomous decision-making and mutual misjudgment, conflicts between the two countries would possibly be escalated and lead into a war of destruction of humans and robots.

Given the lack of morality and pattern of human behaviors in the current machine programming and processing. No one can eliminate the possibility of a world war triggered by robots' not absolutely wrong but partial judgments. Human warfighters remain necessary to play at least a "guidance" role to set mission goals and create larger strategic plans, despite the likelihood that even tactical decisions have strategic effects.[91] Moderate controls are necessary.

One of the original intentions of the development of AWS could be to reduce the casualties of human fighters on the battlefield. But from another perspective, but evolution is always faster than exception. UAVs have traditionally been used for reconnaissance and surveillance, but today they are being employed in roles and applications that their designers never envisioned.[92] Thus there is the possibility that initial considerations and assurances would be put behind the mind once the technology is perfected. Same situation could also happen to AWS and AI technologies. Assuming that if one day the AWS is actually used widely and this situation becomes reality, its impact on all aspects could be "tremble with fear."

3.1.2. The problem of setting control

The prospects of arms control for AWS is not totally without hope, but there is still a long way to go. United Nations Secretary-General António Guterres stated that, "Arms control has always been

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[90] MTGR EOD, Better Access. Reduces Exposure, Roboteam, https://robo-team.com/mtgr-eod/;

[91] Heather M. Roff, "The Strategic Robot Problem: Lethal Autonomous Weapons in War", in *Journal of Military Ethics*, Vol.13, No.3,2014;

[92] Elizabeth Bone, Christopher Bolkcom, Unmanned Aerial Vehicles: Background and Issues for Congress, Report for Congress Received through the CRS Web, Order Code RL31872, April 25, 2003; https://fas.org/irp/crs/RL31872.pdf;

motivated by the need to keep ahead of the challenges to peace and security raised by science and technology" and emerging means and methods of warfare.[93] Arms control map onto the incredible numerical, economic, and scientific growth of mankind over the past century and it illustrates the power of an overarching, positive theme, yet each works through human institutions, which evolve slowly. [94] The history of arms control has shown that successful cases have generally met two or at least one of the following conditions: One is that the weapon system threatens international security and strategic stability, such as nuclear weapons and anti-missile systems; another is that weapon systems seriously challenge humanitarian and human rights thus pose a great threat to civilians, such as biological and chemical weapons, laser blinding weapons, etc. Judging from the current situation, AWS may pose a big challenge in both areas, but the specific ways of impact are still unclear. It is foreseeable that the militarization of artificial intelligence has become an unstoppable trend. What can be done at present is to limit the field and level of its development and draw a red line for it, thus to prevent AWS from damaging strategic stability and threatening the safety of civilians.

China, Israel, Russia, South Korea, the United Kingdom, and the United States are investing heavily in the development of various autonomous weapons systems, while Australia, Turkey, and other countries are also making investments.[95] Countries are full of expectations to AWS and AI. Prototypes of autonomous ground robots, fighter jets, submarines, ships and «swarms» are being developed and tested by technologically advanced nations. The US, Russia, China, and Israel are the frontrunners, with others, such as the UK and South Korea, following their lead.[96] Although United Kingdom is not in a leading position, but many efforts had been made through years. Taking note of the breakthroughs in AI in the early 2010s, the British Government has since 2015 identified the need to dedicate more resources and make a more concerted policy effort to ensure that the UK can remain at the global forefront in the field.[97] While on the other sides of the world, the US invests 54.6 billion of euros per year, which represent four times EU member States spending

[93] The Militarization of Artificial Intelligence, United Nations, New York, NY, August 2019, https://reliefweb.int/sites/reliefweb.int/files/resources/TheMilitarization-ArtificialIntelligence.pdf;

[94] Ronald F. Lehman II, Learning from the arms control experience, Arms Control;

[95] Stopping Killer Robots Country Positions on Banning Fully Autonomous Weapons and Retaining Human Control, 2020 Brian Stauffer for Human Right Watch, August 2020, https://www.hrw.org/report/2020/08/10/stopping-killer-robots/country-positions-banning-fully-autonomous-weapons-and#_ftn12;

[96] Daniele Amoroso, Edited by the Heinrich Böll Foundation, Autonomy in Weapon Systems The Military Application of Artificial Intelligence as a Litmus Test for Germany's New Foreign and Security Policy, Volume 49, PUBLICATION SERIES ON DEMOCRACY, Task Force on Disruptive Technologies and 21st Century Warfare, 2018;

[97] Artificial Intelligence, Strategic Stability and Nuclear Risk; SIPRI; 2020

combined, Russia had doubled its investments between 2012 and 2015 and according some prospections China will override its American competitor by 2022,[98] which China set itself the goal of becoming the leader in the field of AI by 2030, to challenge US dominance.[99]

The issue of arms control of AWS has caught attention and making progressed for years. For example, back in 2014, there were meetings. The ICRC's expert meeting was to gain a better understanding of the range of issues raised by autonomous weapon systems and to share perspectives among government representatives, independent experts and the ICRC. It brought together 21 States[100] and 13 independent experts, including roboticists, jurists, ethicists, and representatives from the United Nations and non-governmental organizations.[101] However, the process of further progress towards substantive development had become very bumpy from the moment when this issue has officially become one of the subjects of international arms control discussions. Germany claim that nothing short of "an important milestone" has already been reached with the 2019 report cited above, even describing the adopted "eleven guiding principles"[102] as a "politically binding regulation,"[103] which is an important milestone was reached at the meeting of CCW States Parties that the 125 participants for the first time reached agreement on guiding principles relating to the use of lethal autonomous weapons systems.[104] From the current point of view, whether the future content is the prohibition of AWSs or the restriction of development, it will be difficult. Anxiety and uncertainty of the technology and its development is one of the reasons

[98] "A corporate mind-set favourable to innovation is critical", Interview of Marwan Lahoud in European Defense Matters, A magazine of EDA, 2016, Issue 10, P18-19;

[99] Cate Cadell and Adam Jourdan. "China Aims to Become the World Leader in AI, Challenges U.S. Dominance," Reuters, 20 July 2017, https://www.reuters.com/article/us-china-ai/china-aims-to-become-world-leader-in-ai-challenges-u-s-dominance-idUSKBN1A5103

[100] Algeria, Brazil, China, Colombia, France, Germany, India, Israel, Japan, Kenya, Mexico, Norway, Pakistan, Qatar, the Republic of Korea, the Russian Federation, Saudi Arabia, South Africa, Switzerland, the United Kingdom and the United States.

[101] Expert meeting, autonomous weapon system technical, military, legal and humanitarian aspects; Geneva, Switzerland , March 2014;

[102] Annex IV, Report of the 2019 session of the Group of Governmental Experts on Emerging Technologies in the Area of Lethal Autonomous Weapons Systems, Convention on Prohibitions or Restrictions on the Use of Certain Conventional Weapons Which May Be Deemed to Be Excessively Injurious or to Have Indiscriminate Effects, CCW/GGE.1/2019/3, https://undocs.org/en/CCW/GGE.1/2019/3;

[103] Frank Sauer, Stepping back from the brink: Why multilateral regulation of autonomy in weapons systems is difficult, yet imperative and feasible, International review of the Red Cross, No. 913, March 2021, https://international-review.icrc.org/articles/stepping-back-from-brink-regulation-of-autonomous-weapons-systems-913#footnoteref5_yz49zau;

[104] German Federal Foreign Office, "Foreign Minister Maas on Agreement of Guiding Principles relating to the Use of Fully Autonomous Weapons Systems", press release, 1 November 2019, available at: www.auswaertiges-amt.de/en/newsroom/news/maas-autonomous-weapons-system…;

why it caught attention, which has also become an important factor hindering the substantive achievement of results in the arms control of AWS.

On one hand, people are concerning that AI will inevitably advance to a certain level where decision makers will believe that the possible way to maximizing the effectiveness of a weapon and attack is to eliminating human intervention and allowing the system to determine the complete chain from target identification to attack. On the other hand, those who oppose controlling the development of AWS believe that AWS will eventually be "smart" enough to learn and strictly follow the rule and do even better than human. These states – Australia, Israel, Russia, South Korea, and the United States – repeatedly expressed their desire to explore potential "advantages" or "benefits" to developing and using autonomous weapons systems.[105] Either way, these points is based on the estimation of the development and consequences of AWS and AI related technologies. And this estimation itself especially the evaluation of the consequences of technological development is highly controversial[106], making it difficult to effectively bridge gap between different positions.

The discussion and disagreements on the impact of AWS on strategic stability is around the predicting the consequences of the uncertainty of technological developments. Previous arms control and prohibition treaties targeted specific weapons categories, in most cases due to their harmful effect.[107] AWS arms control does not have a clear specific target, which it is still evolving rapidly. It might take years or even decades for governmental negotiators to reach an agreement on an AI arms control treaty. Given how fast AI technology evolves, officials may find that the eventual outcome of any international negotiation is out of tune with technological reality and obsolete from the get go, especially if a treaty is based on technical characteristics.[108] This means that arms control of AWS can only be a preventive control over the potential consequences of

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[105] Matta Busby, Killer robots ban blocked by US and Russia at UN meeting, Campaigners want to ban the 'morally reprehensible weapons' INDEPENDENT, September 2018, https://www.independent.co.uk/life-style/gadgets-and-tech/news/killer-robots-un-meeting-autonomous-weapons-systems-campaigners-dismayed-a8519511.html;

[106] Brad Allenby, "Emerging Technologies and the Future of Humanity," *Bulletin of the Atomic Scientists*, Vol. 71, No. 6 (November 2015), pp. 29-38。

[107] Altmann, Jürgen, Asaro, Peter, Sharkey, Noel, and Sparrow, Robert, 'Armed military robots: Editorial', *Ethics of Information Technology*, 15:2, 2013; https://books.google.com/books?hl=zh-CN&lr=&id=-cv3XmNcjDsC&oi=fnd&pg=PR9&ots=Q707WlLxp-&sig=ULpSLwXMqVRtbKKfwbynO7rISoU#v=onepage&q&f=false;

[108] Vincent Boulaninn, Regulating military AI will be difficult. Here is a way forward; Bulletin of the Atomic Science 75years and counting; 3 March 2021, https://thebulletin.org/2021/03/regulating-military-ai-will-be-difficult-heres-a-way-forward/#.YJGQ39ZQOuA.mailto;

technological developments that have not yet been fully demonstrated.[109]   As a start it has been pointed out that a preventive ban on autonomous weapons systems must focus on prohibiting the delegation of authority to kill to machines.[110]

The game between power politics and morality will be one of the factors that determine whether the arms control of AWS and AI can be achieved. One of the reasons why control of AWS has become an important issue is due to ethical concerns. Deep worries about the potential military efficacy of AI technologies and the ethical concerns about the military application of this advanced technology, have brought international community together to call for a control and regulation of the development of AWS. In the ethical debate over AWS and AI, some institutions and countries such as France acknowledges that removing human control from the use of force raises complex ethical legal, operational, and technological concerns.[111] The argument that the decision to kill should not be surrendered to the machine is ethically persuasive.

The problem is that only ethical motivations alone are not enough to push the arms control of AWS into reality. Mary Wareham (2017) points out that fully autonomous weapon systems are under development in many countries, The United States, China, Israel, South Korea, Russia and the United Kingdom.[112] In particular, the United States, Russia, and China have shown reluctance in supporting the legal prohibition of the development of AWS because they fear that such a regulation could be disadvantageous for their military strategy.[113] Arms control is one of the product of power politics, and the results of arms control are often reflected in the calculation of realistic interests and negating of major countries. Therefore, the further progress in arms control of AWS depends not only on the gathering of stronger social forces at the moral level, but also more importantly obtaining sufficient motivation on national security issues.

Arms control of AWS needs to meet at least three conditions. Firstly, there are prominent ethical disputes, especially a clear consensus on whether AWS can truly achieve absolute autonomy.

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[109] Denise Garcia, "Future Arms, Technologies, and International Law: Preventive Security Governance,"*European Journal of International Security*, Vol. 1, No. 1 (February 2016), pp. 94-111.

[110] Asaro, Peter, 'On banning autonomous weapon systems: Human rights, automation, and the dehumanization of lethal decision-making', International Review of the Red Cross, 94:886, 2012; https://www.cambridge.org/core/journals/international-review-of-the-red-cross/article/on-banning-autonomous-weapon-systems-human-rights-automation-and-the-dehumanization-of-lethal-decisionmaking/992565190BF2912AFC5AC0657AFECF07;

[111] Government of France, Statement to the UN General Assembly First Committee on Disarmament and International Security, October 26, 2015, https://reachingcriticalwill.org/images/documents/Disarmament- fora/1com/1com15/statements/26October_France.pdf

[112] Dr STEVE T. MCKINLAY, Swarm Technology and Emergence in Lethal Autonomous Weapon Systems, Wellington Institute of Technology, School of Information Technology;

[113] Daisuke Akimoto, International Regulation of "Lethal Autonomous Weapons Systems" (LAWS): Paradigms of Policy Debate in Japan, Asian Journal of Peacebuilding Vol. 7 No. 2 2019;

Secondly, is that major countries do not believe that AWS are necessity for the military. Thirdly, is the security risks of AWS can be obviously presented to the international community.[114] Obviously, it is difficult to achieve the first and second condition, which means that the process of arms control for AWS will continue to present a struggle situation between moral and political. And the foreseeable result will hardly be good. Some scholars say frankly: "Especially given today's globalized culture, and the strategic and military advantages that emerging technologies can provide, it is highly unlikely that meaningful constraints on technological evolution, whether derived from cultural, competitive, or religious foundations, will be successful."[115]

Regarding the opinion that AWS will lead to arms race and technology proliferation, some scholars believe that such proliferation effect will not be particularly strong, because the proliferation and military application of high and new technologies require strong organizational capabilities and infrastructure support. For example, Andrea Gilli and Mauro Gilli in their book pointed out that even wealthy, advanced and militarily capable countries such as the US, the UK, Germany and Franc have struggled to produce or adopt such platforms.[116] In terms of the possibility of extremists using AWS, the counterargument is that compared with existing unmanned equipment, terrorists may prefer the attack equipment and attack patterns they are already familiar with. Thus AWS and AI may not be a better choice for terrorist.[117] Although given the risk that it could be extremely useful to terrorists and repressive governments thus believe it is more ethical to forego their potential benefits to minimize the potential harm that could come from rogue actors using the same technologies,[118] counterargument is that if the bad actors might be able to deploy these types of systems anyway, then it may be unwise for countries like the United States to forego having the same technologies for defensive purposes.[119]

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[114] Nicholas Marsh, "Defining the Scope of Autonomy," Peace Research Institute Oslo (PRIO) Policy Brief, No. 2, 2014;

[115] Brad Allenby, "Emerging Technologies and The Future of Humanity," *Bulletin of the Atomic Scientists*, Vol. 71, No. 6 , November 2015, https://journals.sagepub.com/doi/full/10.1177/0096340215611087;

[116] Andrea Gilli and Mauro Gilli, "The Diffusion of Drone Warfare? Industrial, Organizational, and Infrastructural Constraints: Military Innovations and the Ecosystem Challenge," *Security Studies*, Vol. 25, No. 1, February 2016; h t t p s : / / w w w . a c a d e m i a . e d u / 6 7 7 6 1 9 8 / The_Diffusion_of_Drone_Warfare_Industrial_Organizational_and_Infrastructural_Constraints_Military_Innovations_a nd_the_Ecosystem_Challenge_forthcoming_in_Security_Studies_;

[117] Brian Jackson and David Frelinger, "Emerging Threats and Security Planning: How Should We Decide What Hypothetical Threats to Worry About?" Occasional Paper, Santa Monica, CA: Rand Corporation, 2009. https://www.rand.org/content/dam/rand/pubs/occasional_papers/2009/RAND_OP256.pdf;

[118] Human Rights Watch. 2016. "UN: Key Action on 'Killer Robots.'" December 16. https://www.hrw.org/print/297850;

[119] Irving Lachow, "The Upside and Downside of Swarming Drones," *Bulletin of the Atomic Scientists*, Vol. 73, No. 2, February 2017, https://www.tandfonline.com/doi/full/10.1080/00963402.2017.1290879;

Although the various risk has never been reduced, an important factor that further weakens the country's willingness to promote AWS arms control is that such technology is remain profitable. AWS represented by unmanned aerial vehicles (UAVs) have increasingly become a powerful tool for countries to strengthen their security strategies, whether it is to avoid their own personal casualties or to carry out special combat missions such as counter-terrorism. If the effectiveness of the operational pattern of AWS is repeatedly being affirmed through different kinds of missions, it will encourage other countries to follow this approach and promote the development and application of AWS on a larger scale and deeper level.

Regardless of the form of arms control, it would require the political determination of the country to get achievement and to witness the results. AWS and AI technology have impact on the international law and human security, but they are not serious enough to arouse serious concerns of future to promote substantive mechanism among state actors, especially these who are well developed. Concerns about AWS and AI technology are closely linked to the rapid technological achievements. And the uncertainty of technological development also makes it difficult for people to reach a consensus on the possible negative effects, which is an obstacle on the way to arms control.

3.2. Mapping the approaches of setting control

The current status of arms control of AWSs shows the hard working of the international community to strengthen the supervision of weapon systems. Although it has reached a certain consensus on preventing humanitarian disasters or damage to human dignity that may be caused by its application, on how to promote arms control negotiations and establishment of a legal system are progressing slowly. Distrust between the international community and countries has aggravated the sense of insecurity. Thus the existing measures have become even more important.

3.2.1. Steps to autonomous weapon system arms control

Many nations and non-governmental organizations have officially stated that measures should be taken to prohibit the development of AWS by 2020.[120] This idea are mostly dominated by small and medium-sized countries and the major powers still have many different opinions on the issue of restricting AWS. The discussion about restricting and prohibiting the development of AWS shows a

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[120] Campaign to Stop Killer Robots, https://www.stopkillerrobots.org/;

bottom-up process. Concerns about the risks of AWS first came from academia.[121] British scientist Noel Sharkey wrote an article in 2007 to warn that "We are sleepwalking into a new world, when and where to kill and kill anyone is determined by the machine<...> It is imperative to establish international rules and ethics, otherwise it will be too late."[122]

Sharkey co-founded the International Committee for Robot Arms Control (ICRAC) in 2009 and played a central role in creating the conditions for launching the Campaign to Stop Killer Robots,[123] with the purpose of promoting the international community to form a legally binding agreement to prohibit the development and use of AWS. In 2012, Human Rights Watch issued a report titled "Against Killer Robots", arguing that the autonomous trend of weapon systems will profoundly challenge laws and ethical norms, so a proactive ban must be enacted as soon as possible.[124] As a foundation, the Campaign to Stop Killer Robots was established in London, England, in 2013. As a coalition organization, the members of the campaign include 63 non-governmental organizations, including Human Rights Watch, Amnesty International, International Committee for Robot Arms Control, the Pugwash Conferences on Science and World Affairs, the International Peace Bureau, and so on. Since then, the campaign has become the most active and prominent social force in the international community in promoting arms control of AWS. Through popular propaganda, academic exchanges, and organizational activities, it has extensively participated in various international organization consultations and talks on AWS. In 2015, more than 1,000 internationally famous scientists jointly issued an open letter warning of a possible arms race in military artificial intelligence and calling for a prohibition of the development of offensive AWS. The open letter emphasized that "Artificial intelligence technology has reached a tipping point...the risks are extraordinary <...> the question that concerns human survival today is whether to start a global arms race in artificial intelligence, or to take precautions from the starting point." [125]

In global security governance, varieties of actors contribute well to not only the setters of issues and discourse, but also the promoters and even the shapers of the governance process. Extensive views from academia and civil society have directly pushed the issue of arms control of AWS into

[121] Laurie Calhoun, "The Strange Case of Summary Execution by a Predator Drone," *Peace Review*, Vol. 15, No. 2 May 2003, pp. 209-214;

[122] Noel Sharkey, "Robot Wars are a Reality," *The Guardian*, August 18, 2007.

[123] Amoroso, D., Tamburrini, G. Autonomous Weapons Systems and Meaningful Human Control: Ethical and Legal Issues. *Curr Robot Rep* **1,** 187–194 (2020). https://doi.org/10.1007/s43154-020-00024-3;

[124] *Losing Humanity: the Case against Killer Robots*, 2012, Human Rights Watch, http://www. hrw.org/sites/default/ files/reports/arms1112_ForUpload.pdf.

[125] Samuel Gibbs, "Musk, Wozniak and Hawking Urge Ban on Warfare AI and Autonomous Weapons," *The Guardian*, July 27, 2015.

the government level. Under the framework of the United Nations, multiple mechanisms have launched discussions on restricting the development of AWS. One of it is the Human Rights Council has submitted numerous reports to analyze the military application of autonomy and artificial intelligence technology which will have the possible impact on human rights and international law. In the 2010 interim report, it was stated that "not only should the challenges brought about by this technological advancement be emphasized, but also proactive measures and approaches should be emphasized to ensure that the capacity of such technologies to promote more effective compliance with international human rights and humanitarian law is optimized".[126] The second is the First Committee of the United Nations General Assembly, Disarmament and International Security Committee. Since 2013, AWS have been on the agenda of the commission's annual meetings, with an increasing number of countries expressing concerns or worries about AWS.[127]

The aim of the CCW is to restrict or prohibit certain weapons that may cause unnecessary casualties or threaten the safety of civilians indiscriminately, which is also one of the international community's ethical concerns about AWS. AWS is a typical example of artificial intelligence weapons, and relevant discussions are of great significance to the international community's regulation of AI weapons. Conference in 2013, the participating parties agreed to set up an informal meeting of experts the following year to discuss AWS systems. Participants included not only representatives of States parties to the CCW, but also representatives of non-States parties as observers, as well as experts from various international organizations, non-governmental organizations and academic institutions. The topics discussed included the technological trends in AWS, the definition of concepts, and the ethical, legal, and security issues.[128]

With the participation and contributions of governments and international organizations, the group of governmental experts has held meetings to discuss important issues such as the definition and characteristics of the AWS system in 2014, human computer interaction and the application of international humanitarian law in AWS. As one of the core features, the concept of "autonomy" has caught many attention and always been put in the decision. At the meeting in 2015, some experts highlighted the dual-use characteristics of AWS. Regarding to this issue, participating experts at the

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[126] Philip Alston, "Interim report of the Special Rapporteur on extrajudicial, summary or arbitrary executions," A/65/321, United Nations, August 2010;

[127] Campaign to Stop Killer Robots, https://www.stopkillerrobots.org/;

[128] [128] *Report of the 2016 Informal Meeting of Experts on Lethal Autonomous Weapons Systems (LAWS)*, 2016, http://www.unog.ch/80256EDD006B8954/ (httpAssets)/DDC13B243BA863E6C1257FDB00380A88/$file/ReportLAWS_2016_AdvancedVersion.pdf;

meeting discussed the systematic approach to AWS, the legal framework for regulating the civil autonomous system, and the nature of dual use export control regimes.

The existing Chemical Weapons Convention and Biological Weapons Convention regulate the export control of dual-use technologies and products, focusing on the purpose of usage rather than the general purpose, which properly can provide lessons and examples for autonomous technologies export controls. However, some representatives argued that it is too early to discuss the export control of AWS without a clear definition, and there is still much debate about whether it can be classified as a traditional weapon.[129]

The process reached a new breakthrough at the end of 2016 when the Review Conference of CCW held in December, decided to establish a Group of Governmental Experts in order to elevate the discussion of AWS to a more formal level. For the framework of the CCW, which has been progressing tortuously, the speed at which AWS arms control has gained attention to move forward can be described as unusual.[130] In the same year, the report pointed out that the participants agreed that the rules of international humanitarian law could apply to all weapon systems including LAWS.[131] This provided a reference to the international community as a first step to control.

The first formal meeting of the Group of Governmental Experts related to emerging technologies in the area of lethal autonomous weapons systems in the context of the objectives and purposes of CCW was held in Geneva from 13 to 17 November 2017.[132] In a video released by senior AI researchers at the CCW conference in Geneva in November 2017, small AI robots resembling killer bees use the AI technology as programmed facial recognition system to identify and shoot students in a classroom at first sight. The killer bee carries 3 grams of explosives, and with a well-designed attack algorithm locks on the target and attacks independently after receiving the attack command. This means that killer bee robot can freely dispose of human life once activated. Although it has not actually happened in real life and it is foreseen for a long time, facing the fact that robots have the capability to eliminate human life by itself officially is a breaking point of AI technology. The way how to grasp the knowledge and gap between new technology and law will be crucial for the future arms control.

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[129] CCW, Report of the 2016 Informal Meeting of Experts on Lethal Autonomous Weapons Systems (LAWS), pp. 12-14;

[130] Frank Sauer, "Stopping 'Killer Robots': Why Now Is the Time to Ban Autonomous Weapons Systems," *Arms Control Today*, October 2016, http://www.isodarco.it/courses/andalo18/doc/sauer_ Stopping- Killer-Robots.pdf.

[131] CCW, Report of the 2016 Informal Meeting of Experts on Lethal Autonomous Weapons Systems (LAWS), p. 8.

[132] CCW/GGE.1/2017/WP.1. Available at http://undocs.org/ccw/gge.1/2017/WP.1;

At the third meeting held in August 2018[133], the delegations broadly agreed on accountability that the responsibility for the deployment of any weapons system including AWS in an armed conflict area is with the state actor who used the weapons system itself. The 2018 report also clearly states that "the responsibility of human beings for decisions about use of weapons systems must be retained, as responsibility cannot be transferred to machines. This should be considered throughout the life cycle of the weapon system."[134]

Delegations recognized the dual-use nature of autonomous technologies and emphasized that efforts within their mandate should not hinder the rational development and use of these technologies in the civilian field, nor prevent the acquisition of these technologies.[135] In the same year, the 2018 report clearly pointed out: "Discussions and any policy measures within the scope of the CCW should not hinder progress or access to the peaceful use of intelligent autonomous technologies."[136] In addition, there were the general opinions of the participants also believed that civil organizations and the scientific community should play an important role in exploring possible future problems and solutions in accordance with the rules of procedure determined by CCW, such as preventing AI technology in the civilian field from falling into the hands of illegal organizations. Also at the meeting in August 2018, a group of experts discussed whether it is necessary to start formal negotiations on the issue of fully AWS driven by AI and to formulate a treaty on banning fully AWS. However, due to opposition from the United States, Russia and other countries, the proposal failed to reach an agreement eventually.

At the fourth meeting held in March 2019, the parties discussed the technical characteristics, military applications, human computer interaction and the application of international law of the AWS system, however no significant progress was made. And the direction of human law issues related to AWS is still unclear. On the issue concerning the future regime of AWS, three different views were generally put forward by the parties. First, a new additional protocol should be formulated under the framework of the CWC, or a legally binding treaty should be formulated

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[133] "Report of the 2018 Group of Governmental Experts on Lethal Autonomous Weapons Systems," CCW/GGE.2/2018/3, 31 August 2018, https://www.unog.ch/80256EDD006B8954/(httpAssets)/20092911F6495FA7C125830E003F9A5B/$file/2018_GGE+LAWS_Final+Report.pdf, p. 5.

[134] [134] "Report of the 2018 Group of Governmental Experts on Lethal Autonomous Weapons Systems," CCW/GGE.2/2018/3, 31 August 2018, https://www.unog.ch/80256EDD006B8954/(httpAssets)/20092911F6495FA7C125830E003F9A5B/$file/2018_GGE+LAWS_Final+Report.pdf, p. 5.

[135] Russian Federation, "Russia's Approaches to the Elaboration of a Working Definition and Basic Functions of Lethal Autonomous Weapons Systems in the Context of the Purposes and Objectives of the Convention," April 4, 2018, https://www.unog.ch/80256EDD006B8954/(httpAssets)/ FC3CD73A32598111C1258266002F6172/$file/CCW_GGE.1_2018_WP.6_E.pdf, p. 2;

[136] CCW, *Report of the 2018 Group of Governmental Experts on Lethal Autonomous Weapons Systems* (*CCW/GGE.2/2018/3*), August 31, 2018, https://www.unog.ch/80256EDD006B8954/(httpAsse ts)/20092911F6495FA7C125830E003F9A5B/$file/2018_GGE+LAWS_Final+Report.pdf, p. 5;

outside the framework to comprehensively ban the research, development, production and use of AWS. The second is to give priority to drawing up a political declaration and confidence-building measures on the basis of the possible guiding principles[137] that have already been adopted. Third, the existing international humanitarian law is completely sufficient, and there is no need to formulate new rules. It is possible to ensure that the development of the AWS system meets the requirements of international humanitarian law by strengthening domestic laws and regulations on arms review.

Delegates were basically in agreement on the need for humans in the operation of AWS. Experts attended the meeting emphasized the importance of human control, supervision and judgment in the use of force. Although the existing international law does not stipulate human control, humans must comply with the international humanitarian law when using weapons, which requires humans to provide necessary control and supervision over machines. The agreement on the bottom line is that the fully AWS with life and death decisions without any human intervention are absolutely unacceptable.

However, some participants still expressed disappointment at the failure of the expert group to achieve significant results after years of discussion, and said that starting a new course outside the framework of the CCW and reaching an agreement of international treaty that completely bans AWS is also a possible option. At present, there are still big differences on the views of AI weapons and the need for formulate special laws and regulations and it might be difficult to reach an agreement in the short term. With the continuous development and evolution of science and technology, it is difficult to predict whether AWS and AI weapons will become the defender of humanity in the future or the opening of Pandora's box.

The current approach to arms control shows CCW plays an important role in the arms control of AWSs. Although the process is slow, it is moving towards to an optimistic way.

3.2.2. Arguments under the frame of CCW

The concept of autonomous weapon system is widely controversial. There is not enough consensus among countries about the concept of autonomous weapon system. For example, what would qualify as an autonomous weapon? Should its development, production or the usage by completely banned? Or only some certain part of it? Are the autonomous weapons system a blessing or a curse for civilians? Take the concept of "autonomy" for example. Autonomy has

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[137] Group of governmental experts on emerging technologies in the area of lethal autonomous weapons systems, commonalities in national commentaries on guiding principles, https://documents.unoda.org/wp-content/uploads/2020/09/Commonalities-paper-on-operationalization-of-11-Guiding-Principles.pdf

different meanings in different fields. Autonomy in the engineering sense usually refers to the ability of a machines that can operate independently without human intervention. In the philosophical sense, autonomy mainly refers to moral independence. In political science, autonomy is more closely related to self-management. In the field of military field, the meaning of autonomy is very controversial. What kind of weapon system can be called "autonomous"? Different scholars and countries have different definitions.

As mentioned earlier, there is a widespread dispute about certainty on the definition of AWS and how it should be defined. Countries regarding whether AWS should be defined currently have different opinions. There are different definition for Autonomous Weapons System. On one hand, the description from US Department of Defense might be the one accepted most generally "an Autonomous Weapon System is a weapon system to have capable of selecting and engaging enemy targets without the intervention of any human operator"[138]. And we can see other descriptions from ICRC "Autonomous Weapon Systems are defined as any weapon system with autonomy in the critical functions of target selection and target engagement. That is, a weapon system that can select (i.e. detect and identify) and attack (i.e. use force against, neutralize, damage or destroy) targets without human intervention".[139] This definition is relatively objective and clear, pointing out the autonomy and other key characteristics of autonomous weapon system.

On the CCW meeting in 2014, many of the delegates believe that it is necessary to identify some of the key elements to describe the concept of autonomy, including "meaningful human control", "predictability", "ability to select and lock target in the context of without human intervention", "human participation in design, testing, review, training and use".[140] At the same time, some delegates believed that it is too early to start working on the definition of LAWS and it is not beneficial.[30] The definition should not be used as a tool to predict the future trend or try to draw a line between acceptable and unacceptable systems. One of the reason why the parties involved in the conference have great differences on the definition of the issue is that there is no fully AWS at present. And the different levels of development of autonomous technology in various countries also profoundly affects the understanding and position on the definition of AWS.

Secondly, in terms of technology there are four approaches to discuss the characteristics of AWS currently. The first is the "Separative approach", which includes the "via negativa" and the "via

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[138] U.S. Department of Defense, "Autonomy in Weapons Systems," directive no. 3000.09 (November 21, 2012)

[139] ICRC – International Committee of the Red Cross 2016: Autonomous Weapon Systems. Implications of Increasing Autonomy in the Critical Functions of Weapons, https://shop.icrc.org/autono-mous-weapon-systems.html?___store=default;

[140] CCW, Report of the 2014 Informal Meeting of Experts on Lethal Autonomous Weapons System

positive", which excludes features and concepts that have nothing to do with the goals and objectives of AWS. At the same time, collect features and concepts that are clearly related to the goals and objectives of CCW. The second is the "Cumulative approach", which is to add feature categories to the main list. And then evaluate the concept and feature according to certain technical, legal, humanitarian or political security criteria to clarify their differences and determine its relevance to the CCW. These categories include technical characteristics such as physical performance, target performance, as well as factors and characteristics such as human machine interface, human machine relationship, reliability and predictability. The every step of the development of the technology is important here. These would help to build a mutual understanding and eliminate the possible illegitimate acknowledge. Then is the Accountability Approach, which takes into account the types and characteristics of decisions that humans passed on to the machines, based on state and human accountability for machine behavior as the main criteria. Finally is the "Purpose oriented and effect-based approach", which focuses on the expected consequences of emerging autonomous systems and technologies to determine the relevant characteristics of AWS. These four paths all have [33] many supporters, while they are still being debated. These approaches reflect some possible obstacles and expectations of the countries.

The issue of "whether and when Artificial General Intelligence will come" becomes a prospective of the future. Some believe that the realization of Artificial General Intelligence or full AI is not possible any soon, but still need to take a long time to develop, while others believe that Artificial General Intelligence could come to reality in the next few decades. No matter when it will be realized eventually, it is necessary to plan and prepare for the future. Similar to this controversy there are issues such as "whether AWS exists currently?" In the meantime, some other representatives said that some precursor technologies are already exist, and some countries have deployed technologies with increasing degrees of autonomy.

Whether the AWS requires additional supervision beyond international humanitarian law is also one of the topics discussed by CCW. Whether the existing international humanitarian law is sufficient to regulate the use of all weapon systems including AWS remains on the table of the decision as well as if it can effectively supervise the research and development of AWS. History has shown that new weapon technology always triggers extensive discussions on the application of law, and attempts to ban such new weapons with technology would have failed because of the possible advantage in a war that it might bring. And lead to an insecure and unstable situation. Therefore, it can be a better choice to allow technological development with careful supervision and in the meantime ensuring the compliance with existing legal requirements. If apply the existing

international humanitarian law to AWS ideally, as this could prematurely legalize the weapon system without being well prepared.

Last but not least, divergence in the future as should the international community do preventive prohibition or temporary indulgence or even encouragement of the development of AWS? Just as previous experience dealing with disruptive technologies such as gunpowder and nuclear weapons have revolutionized the form and nature of conflict and war, the emergence and development of AWS may also have a significant impact on the act of armed conflict. Given the unpredictability of this change and potentially devastating consequences, many delegations under the CCW have called for a preventive measure to ban the development and research of AWS until security issues are clarified.　Corresponding policies include the formulation of CCW protocol, binding national statements and guidelines politically for future action.

Autonomous technology may give more chance to the weapon systems that have the ability to discriminate. The United States tends to believe that AWS will [36] bring a lot of humanitarian benefits into the military field. Specifically, AWS would enable military operations in communications degraded or denied environments in which traditional systems may not be able to operate as well as "automated target identification, tracking, selection, and engagement functions can allow weapons to strike military objectives more   accurately and with less risk of collateral damage" or civilian casualties. Therefore, the United [37] States believes that instead of criticizing and stopping the research and development of AWS, it should encourage AWS related technological innovation in   order to promote the purposes and goals of CCW while the technology is under control.

In general,   countries that currently have an advantage in artificial intelligence technology are relatively   conservative in banning this research and development of AWS, while other small and medium-sized countries hope to ban the research and development of it as soon as   possible. The potential benefits that it could bring and the opportunity within is always been a great trigger for countries to strive.

3.2.3. Possible solution to the problem of setting control

An open letter read at the opening of the International Joint Conference on Artificial Intelligence in July 2015 said that artificial intelligence technology could allow fully autonomous weapons to be developed and applied "within a few years, not decades". Even if it can be achieved, as a matter of principle under the IHL, no authorities should be given to AWSs especially regarding to kill.

Therefore they called for an urgent ban on the development, production and use of such weapons systems. However, with more opinion believe that such technological advances, as long as they are controlled within appropriate limits, are legitimate military advances. In some cases, can even help to make armed conflicts more humane and save the lives of the parties involved. According to this argument, abandoning this technology completely is tantamount to fail to properly protect lives. A third opinion is that, it is precisely because AWSs are not human, they may outperform humans in some dangerous situations. And the action of human combatants may be influenced in their fear or anger. At the same time, AWSs can be programmed to identify hostile targets by features such as appearance, heat signature, and airspeed threshold. Leading to conform to the principle of proportionality attack in international humanitarian law. Therefore, these people stress that arms control of AWS is not a total prohibition, but rather an enhancement of effective international regulation.

Maximizing the positive contribution of AWS and AI technology while minimizing its harmful consequences will be one of the greatest challenges. With the eleven guiding principles as a start, all the countries could follow this trend that reaching more consensus on the international level and adjust national policy. Besides, there are at least three possible approaches to pre-emptively regulating or prohibiting the development of AWS through international law. Firstly, the CCW is a legitimate framework for regulating or prohibiting the development of AWS. Secondly, it is feasible for the international community to confirm the applicability of Article 36 of the "Protocol Additional to the Geneva Conventions of August 12, 1949 and relating to the Protection of Victims of International Armed Conflicts (Protocol 1)," adopted in Geneva on June 8, 1977 to AI weapons, and to agree on a "political declaration" of the outcome of the international negotiations around regulating LAWS.[141] Finally, there are maybe no tangible results, perhaps with one of the technological leading countries setting a precedent by fielding autonomous weapons systems,[142] which will intensify the arms race for AWS. Countries might compete to be become a leader in the field, in order to become the rule maker. This situation could hardly lead to a good result globally.

The possible way of arms control for AWS could be multiple. The first is an international treaty commonly used in arms control, or a non-use of AWS statement, which is a formal and binding agreement prohibiting the development of AWS and AI technology or the limitation of their use as

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[141] Daisuke Akimoto, International Regulation of "Lethal Autonomous Weapons Systems" (LAWS): Paradigms of Policy Debate in Japan, Asian Journal of Peacebuilding Vol. 7 No. 2 2019;

[142] Frank Sauer, "Stopping 'Killer Robots': Why Now Is the Time to Ban Autonomous Weapons Systems," *Arms Control Today*, October 2016, http://www.isodarco.it/courses/andalo18/doc/sauer_ Stopping-Killer-Robots.pdf.

mentioned before. Such a treaty will inevitably involve a series of specific issues such as the definition of AWS, compliance verification and violations case. These issues directly affect the beneficials and interests of different countries. Therefore, the expectation of reaching an agreement is not positive.

There are numerous mechanisms available, many of which are collectively referred as "soft law" approaches,[143] which is instruments or arrangements that create substantive expectations that are not directly enforceable, unlike "hard law" requirements such as treaties and statutes. The category relevance to many emerging technologies includes various types of private standards, guidelines, codes of conduct, and principles.[144] For Example, China has called for a treaty to ban the use of lethal autonomous weapons systems, but not their development or production, which is unsurprising given that it is also among the nations most advanced in pursuing such weapons.[145] In the process of research and development, countries could come to an agreement about future regulation or attempt a approach to achieve a better understanding within countries about various risks. Thus, countries could promote codes of conduct for the development and use of AWS. And even approach to coordinate the military application of AWS with international law. But even if it is not directly enforceable, it is difficult to determine whether the behavior is compliance with the norms. While it is questionable how effective such an agreement can be, it could be a possible way to start.

To a large extent, countries could effectively mitigate risks through the creative use of the suite of confidence-building measures that the arms control community came up with during the Cold War. The United States and the Soviet Union had, for instance, regular dialogues, a hotline to help them communicate during nuclear tensions, and scientific cooperation programs aimed at increasing mutual understanding and trust.146 On the other hand, there is also a view that political declaration may not be enough. Based on the way CCW usually operates, one can confidently predict that consideration of a political declaration would involve negotiation of every word, would take years

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[143] Organisation for Economic Co-operation and Development, 2013, International Regulatory Cooperation: Addressing Global Challenges .Paris:OECD Publishing.http://www.oecd.org/env/international- regulatory-co-operation-9789264200463-en.htm;

[144] Gary Marchant and Brad Allenby, "Soft Law: New Tools for Governing Emerging Technologies," *Bulletin of the Atomic Scientists*, Vol. 73, No. 2, March 2017, https://www.researchgate.net/publication/313788116_Soft_law_New_tools_for_governing_emerging_technologies;

[145] Campaign to Stop Killer Robots, "Report on Activities: CCW meeting on lethal autonomous weapons systems," April 9- 13, 2018, https://www.stopkillerrobots.org/wp-content/uploads/2018/07/KRC_ReportCCWX_Apr2018_UPLOADED.pdf;

[146] Vincent Boulaninn, Regulating military AI will be difficult. Here is a way forward; Bulletin of the Atomic Science 75years and counting; 3 March 2021, https://thebulletin.org/2021/03/regulating-military-ai-will-be-difficult-heres-a-way-forward/#.YJGQ39ZQOuA.mailto;

to conclude, and would be the end point.147 The establishment of political declaration is only a temporary measure, thus it is necessary to further negotiation for legally binding instrument. The Campaign to Stop Killer Robots is calling for a legally binding instrument to address such emerging technology by preserving meaningful human control over the use of force.148 As well as despite the fact that no decisions were taken at the CCW meeting, proposals were heard to negotiate a legally binding instrument or treaty, including from many of the 30 countries that explicitly call for a ban on lethal autonomous weapons systems.149   Analytically, the current CCW discussions around AWS focus on the areas of technology, ethics, law and security. The rapid emergence of AWS problems based on AI will have a huge impact on all the areas internationally.

Chapter three presented that there are risk of proliferation. The positive side, AWS in the military field can bring many positive effects, which are unique advantages that distinguish it from a conventional weapon system and it will reduce the threshold of war. AI has a significant dual-use nature, and it is not difficult to transform civilian artificial intelligence into military AWS. Therefore the efforts to control AWS gain more technological support from AI and prohibit the development of AWS are unlikely to work. Competition over AWS development and research will continue. Countries are competing fiercely for advantage in key areas of technology.

The necessity of setting control over the AWS is being showed from different prospectives. Several element is urgently need of attention, such as standardize the research and development and definition of the control function in the AWSs. These will make sure the development of AWSs will always with control of human. Several parts should be pay attention to are: firstly, time interval between human decision making and machine decision making. This will help human to stop machine from doing unexpected thing and give human enough time to react. Secondly, deployment environment should be take into consideration, which will minimize the accidental damage to civilians and innocents. And finally the quality of machine operators such as designer and the skill of operator. This will help to maximize the the advantages of AWSs and minimize the potential malfunction and human negative interface.

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147 Steve Goose, Statement on Options for Future Work, CCW meeting on lethal autonomous weapons systems, Human Rights Watch, March 27, 2019, https://www.hrw.org/news/2019/03/27/statement-options-future-work-ccw-meeting-lethal-autonomous-weapons-systems;

148 Campaign to Stop Killer Robots, Key elements of a treaty, November 2019, https://www.stopkillerrobots.org/wp-content/uploads/2020/04/Key-Elements-of-a-Treaty-on-Fully-Autonomous-WeaponsvAccessible.pdf;

149 Mary Wareham, Diplomatic talks reconvene, CCW Report, Vol. 8, No. 2, Reaching Critical Will, 30 September 2020, https://reachingcriticalwill.org/disarmament-fora/ccw/2020/laws/ccwreport/14777-ccw-report-vol-8-no-2;

There are problems in the process of setting international control. As try to be the dominator in the field, leading countries do not have the willing to set control is that the fear for regulation might be a disadvantageous for their military strategy. And the potential of the AWSs is so great that countries had repeatedly expressed the desire to explore "advantages" or "benefits" in developing and using AWSs. With other reasons like afraid of proliferation in the black market and decrease of the profits from the AWSs, there are still difficulties in setting control on AWSs. Not to mention currently, it has not cause great impact on international security and human rights. Also does not cause great harmful to innocents or civilians yet. There are all the factors that decrease the willingness of arms control. However, as it is mentioned before, there are great challenges from foreseeable future once AWSs is being deployed and developed without human control. Thus the international control is needed.

In terms of approach to aims control of AWS, the role of international organization in world politics has become increasingly important. CCW will continue to be the main platform for international discussion of arms control of AWS. Although there are not many significant achievement, there is breakthrough that consist of working from 125 participants in CCW in 2019 when "Eleven Guiding Principles" is being accepted broadly internationally. Showing us the future is not lost. Besides, small and medium-sized developing countries should be listened during the approach to control.

Although currently there are still difficulties from different aspect, future is positive. There are different solutions and prospects such as through international treaty and other mechanisms of arms control. Despite the fact that might not all of them are promising, the future of AWSs arms control is possible and doable.

Conclusion

The deployment of AWS may have some positive consequences, like decreasing the casualties, improving operation efficiency, reducing the physical and cognitive pressure on officers and soldiers, reducing the burden of the decision-making though improving command and control support systems, reducing the costs of war, fighting within the prescribed scope of moral operations, providing realistic, comprehensive training, expanding the breadth and depth of operations. These have stimulated the arms race and intensified the unstable global situation. The possible benefits of AWS and AI increased investment and research for the core technologies and talents of advanced technology in order to seize the technological advantages and initiatives.

However, in a short period of time, there are problems such as black box that might lead to malfunction. The unpredictability and uncertainty bought by the black box and malfunction might violate sovereignty and cause unnecessary conflict. Moreover, because AWS is based on AI technology, there are problems with accountability during design and operation. Who should take the responsibility remains. Thus, maintaining meaningful human control within the AWS is important, which could stop situations from being escalated by machines and prevent the machine from being completely out of control.

In the future, more and more autonomy will be found in the characteristics of military weapons and systems, which will be used more and more widely in different real scenarios. Whether the emergence of AWSs will bring harm to human society may more and more depend on the capability to make AWSs under control through technical programming and regulatory constraints. AWSs will focus on how to pursue the target successfully instead of thinking about whether it is right. Therefore, that leads to another problem that AWSs does not consider the consequences of the action and the social justice of the attack in the absence of moral judgment and legal statute. AWSs will meet challenges from IHL, which is the principles of distinguishment, the principle of proportionality, and whether it could compliance with the "Martens Clause." AWS neither does have the ability to learn ethical standards nor the standard can be coded into the program. AWS also faces the ethical level as well. This is not only a violation of a certain law or moral standards but also a threat to the whole society. Although there are many challenges from moral and ethical level, but these are not enough for the arms control on AWSs.

AWSs may effect strategic stability. How the emergency of AWS and AI will have an impact on the strategic stability depends on the degree of development and the way how AWS and AI

technology will be applied to the weapon systems. AWSs can provide support to command and control system defenses to make the system more efficient as well as defenses against potential interference. What is more, AWS and AI technology may be used for intelligence, surveillance, and reconnaissance systems that will help to gain intelligence. This will increase the vulnerability of nuclear infrastructure.

The technological process will enlarge the gap between countries. Unlike the first industrial revolution, rather than population size of countries, technologies will become one of the most important elements to national power. And the small or not so well developed countries that might lack the objective technology to develop AWS and AI technologies are also the supporters to total ban or set control on AWS. However, at the same time, countries with technological advantages are lack of willingness to control. One of the reasons behind this is the variety of possibilities and potential benefits in the future. Besides, fear of rivals developing AWS in secret is one of the driving forces behind the development, which reduce global security and led to a new arms race. AI has a significant dual-use nature. Thus, it is not difficult to transform civilian AI technology into military AWS.

Therefore we can learn that, currently AWSs have not greatly threat international security or strategic stability, as well as challenge the humanitarian and human rights, thus leading countries have no willingness to set international control on AWSs. As leading country repeatedly expressed their desire to explore potential "advantages" or "benefits" to developing and using autonomous weapons systems, the AWSs seems quite profitable. An important factor that weakens the country's willingness to promote AWS arms control is fear such a regulation could be disadvantageous for their military strategy. No one will take any risk of losing advantages in field like AWS, especially in the era of AI. Other reasons like AWSs as a set of software program, ban or regulate could led to the proliferation in the black market. It will be even more difficult to set control if that happen. And AWSs as a new technology is too complicated to terrorists all become reasons of no need to set control. Besides, many AWS and AI technology in military were initially designed to meet the needs of special combat environments, does not have great harmful to innocents or civilians yet. However, that does not mean it will not happen in the future.

The necessity of setting control over the AWS is being showed from different prospectives. Several element is urgently need of attention, such as standardize the research and development and definition of the control function in the AWSs. These will make sure the development of AWSs will always with control of human. Several parts should be pay attention to are:

Firstly, time interval between human decision making and machine decision making. This will help human to stop machine from doing unexpected thing and give human enough time to react. In order to clarify the part that human plays in the process of AWSs, the specific restrictions and requirements should be necessary made by human on the identification, decision-making and method selection of their attack targets. Secondly, deployment environment should be take into consideration, which will minimize the accidental damage to civilians and innocents. And thirdly the quality of machine operators such as designer and the skill of operator. This will help to maximize the the advantages of AWSs and minimize the potential malfunction and human negative interface.

Although the total ban of the AWS is almost impossible, the possibility of arms control is not lost. The AWSs gives us a glance off the possibility of the intelligent weapon that can bring change to the warfare. Imposing a total ban will depriving ourselves of tools that can reduce the suffer of people during the war. One of the reasons is that at present, more and more world leaders and military experts of various countries have realized that if the AWS is completely out of human control, the world could slip into a dangerous situation which intensifying arms race, threatening international security and strategic stability, challenging humanitarian and human rights seriously, and posing a threat to human ourselves.

Discussions about AWS have become a topical issue at the international level. The framework of the CCW, which brings together a wide range of national and non-State actors, has become a central platform for international LAWS arms control discussions. CCW has played an important role in promoting the AWS arms control discussion and has achieved some success. However, with increased competition from big powers and the temptation of the militarization of AI, no substantial progress has been made on how to proceed with AWS arms control negotiations and what form of effective international legally binding instrument should be constructed.

Many issues, such as debates over the AWS definition, the pros and cons of AWS military application, and legal challenges, remain unresolved, which slow down the arms control of AWS. Thus, it needs countries to continue and to be even more actively participate in AWS arms control discussions within the CCW framework, managing the risks, ethical and legal challenges posed by AWS. In addition, the negotiations of the Convention also require small and medium-sized developing countries to join together, and their voice needed to be heard and strengthen in the international community. The breakthrough was made in 2019 when all the participants in the CCW for the first time reached the "Eleven Guiding Principles," which is being accepted broadly. As a starter to the future consensus showed the international community that arms control of AWS is

possible and doable. Besides, the arms control of AWSs can start from less relevant field to core technologies. For example, as it is mentioned previously the operation field and operator.

The revolution of AWS and AI will bring unprecedented change to the international community, and the process of change itself has already created unpredictable risks. The use of AWS and AI is like the use of electricity. There are many different ways to use it based on method and level. Countries have their own expectations of AWS and AI. Thus it is almost impossible to prohibit any country from using it. How to have forethought so that the impact of the militarization of technology does not harm humanity itself is a solution to make it better develop in the future.

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Annexes

AI	Artificial Intelligence
AWS	Autonomous Weapon System
CCW	Convention of Certain Conventional Weapons
DOD	US Department of Defense
ICRAC	International Committee for Robot Arms Control
ICRC	International Committee of the Red Cross
IJCAI	International Joint Conference on Artificial Intelligence
IHL	International Humanitarian Law
ISR	Intelligence, Surveillance and Reconnaissance
LAWS	Lethal Autonomous Weapon System
MHC	Meaningful Human Control
NGO	Non-Governmental Organization
OODA	Observe, Orient, Decide, Act
SIPRI	Stockholm International Peace Research Institute
TOS	Third Offset Strategy
UAV	Unmanned Airborne Vehicle
UAS	Unmanned Aerial System
UGS	Unmanned Ground System