• Article •

The Weaponization of Humanoid Robots from the Perspective of the Security Dilemma: Implications for Global Power and Governance

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Abstract: The weaponization of artificial intelligence (AI) is accelerating. Embodied intelligent systems, especially humanoid robots, are expected to dominate the next generation of artificial intelligence arsenal. These platforms are expected to replace human combatants as the primary force on the future battlefield. This article takes the safety dilemma as the theoretical mainline and takes humanoid robot technology as the entry point to construct a multi-level analytical framework that integrates technology, ethics, and international relations, and prospectively grasps the impact of technological changes on war and international relations. This article also calls for "good governance" of technology and proposes that China's great power responsibility is to promote multilateral consensus, cocreate governance structures, and transform survival risks into strategic opportunities.

Keywords: Artificial Intelligence; Humanoid Robots; Security Dilemma; Human Replacement; Global Governance

1. Introduction

Engels pointed out: "Once technical advances can be used for military purposes and have been used for military purposes, they will immediately and almost forcibly, and often against the will of the commander, lead to changes or even revolutions in the way of warfare (Marx, 2012)." This trend became increasingly evident after the mid-to-late 19th century, and its impact has grown. Since the second half of the 20th century, the United States has led a military transformation based on information and space technology. Situational awareness, information transmission, and command and control systems covering land, sea, air, space, cyberspace, and electromagnetic space have become standard features of major power military competition. On this basis, artificial intelligence technology has further achieved a revolution in information processing capabilities and processing methods (Li, 2025). It has set off a new wave of military revolution.

AI weaponization has crystallized into two principal physical embodiments. The first consists of uninhabited aerial vehicles (UAVs). By 2020, roughly 100 states operated UAVs, nearly 20 of which fielded armed variants (Stavrianakis, 2017). In the ongoing Russia–Ukraine war, UAVs have assumed a decisive battlefield role. On 1 June 2025, Ukrainian forces reportedly employed AI-enabled UAVs to strike Russian air bases, claiming the destruction of over 40 strategic bombers (Adams & Lukiv, 2025). A second category comprises lethal autonomous weapon systems (LAWS) that autonomously search for, select and engage targets within pre-programmed parameters. US Department of Defense doctrine stipulates that, once activated, LAWS can select and fire upon targets without further human intervention (Hwang, 2025). These capabilities have provoked sustained international controversy. Citing ethical concerns—combat risk, accountability, and breaches of the principles of proportionality and distinction—approximately 30 states and 165 NGOs advocate a pre-emptive ban on LAWS (Sayler, 2025). While the weaponization of AI has been extensively debated, the specific militarization of humanoid robots remains under-examined. Humanoid robots are biomimetic systems that replicate human morphology and kinetics (Cai & Xie, 2022). They constitute a fusion of AI and advanced robotics (China Academy of Information and Communications Technology, 2024). Conceptually, they are autonomous cyber-physical agents that perceive, decide and act in real-world environments (Matarić, 2007). Their central objective is “human substitution” via embodied intelligence, promising remedies for ageing societies and labour shortages (Korus, 2024).

Especially after the release of ChatGPT in 2022, humanoid robots began to show signs of commercialization, and global tech giants have been betting big, investing significant resources in their development. In an era of aging and soaring labor costs, the commercialization of humanoid robots aligns with the needs of the capitalist model of development and will drive the rapid development of humanoid robotics technology. The United States and China have already invested significant resources in this field. From 2009 to 2024, the United States released a series of policy documents, including the National Robotics Roadmap, the National Robotics Initiative 1.0, 2.0, and 3.0, and the U.S. Robotics Technology Roadmap, all aimed at promoting the development of robotics technology in the United States, with a particular focus on humanoid robots (Xin Zhiyuan, 2024). Since 2017, China has also issued a series of policy documents aimed at promoting the development of humanoid robot technology (General Office of the State Council of the People's Republic of China, 2017). This indicates that all-round competition between China and the United States in the field of humanoid robots has emerged, and the implementation of humanoid robot technology has begun to show signs.

From a military perspective, geography still has great significance. In mountainous, street-like environments, to exert sustained military influence on the region, long-term deployment of ground military forces is required (Kaplan, 2013). The characteristics of humanoid robots meet relevant military needs, which will promote the weaponization of humanoid robots. In fact, the precursors of humanoid robots' weaponization have already appeared. On May 25, 2025, the world's first humanoid robot fighting competition was held in Hangzhou (CCTV, 2025). This indicates that humanoid robots have

already achieved preliminary combat capabilities. Humanoid robots that achieve the integration of mind, brain, and body are not only weapons in their own right, but also possess human-like behaviors such as autonomous learning, multi-scenario operation, and independent decision-making. This will not only overturn the previous logic and form of warfare, but will also profoundly transform human society from the perspectives of security and ethics.

With the continuous advancement of technology, countries are bound to take certain measures to ensure their own security, which may be seen as a threat by other countries, leading to further strengthening of security precautions. Although countries have responded to ensure their own security, the dilemma caused by this constant suspicion and escalating competition has become increasingly severe.

Based on this, this article starts from the technical characteristics of weaponized humanoid robots, prospectively analyzes what changes the technological transformation of humanoid robots will bring to war, how to reshape international relations, and finally provides suggestions to avoid the escalation of security dilemmas caused by technological changes in various countries.

2. Humanoid Robot Characteristics and Weaponization Potential

Humanoid robots derive their disruptive battlefield value from an uneasy marriage of the familiar and the extraordinary. Engineered to replicate human morphology and kinetics, they slip effortlessly into arsenals, crews and tactics designed for flesh-and-blood soldiers; yet beneath this anthropomorphic shell reside computational reflexes, composite musculatures and sensor suites that surpass human limits by orders of magnitude.

2.1 Human-Like Attributes

“Humanization” is the most prominent feature of humanoid robots, which enables them to better adapt to the war environment constructed by humans. For example, weaponized humanoid robots can quickly inherit human weapons. Humanoid robots can directly use equipment in existing arsenals, avoiding the complete elimination of weapon systems due to technological iterations and saving defense spending. The inheritance of existing weapons can quickly form combat effectiveness and form effective human-machine collaborative combat capabilities. As technology gradually improves and matures, humanoid robots will also achieve “swarm” combat capabilities. Currently, drones, as representatives of “swarm combat”, have already demonstrated their special advantages. Self-control is achieved through the algorithms and programs built into the system (Leidy, 2024), Humanoid robots can implement various team tactics of natural human armies, thereby gaining huge battlefield advantages.

2.2 Superhuman Capabilities

Beyond human-like traits, humanoids exhibit superhuman performance. First, their computational “brain” surpasses human cognition. Integration of AI into the physical substrate endows them with

human-like—and often superior—perception, learning and environmental interaction. Consequently, cognitive performance can exceed human baselines. Second, their bodies comprise high-performance actuators, motors and reducers. Advanced polymers—polyetheretherketone (PEEK), polyamide and polyphenylene sulfide—deliver exceptional strength-to-weight ratios. The resulting chassis is lighter yet stronger, faster and more resistant to heat, abrasion and corrosion (808, 2024). Commercial prototypes already exhibit these characteristics 150 pounds. Tesla's Optimus, for example, can dead-lift 68 kg. It can simultaneously carry 20 kg while locomoting at 20 m s^{-1} (Biba, 2025). Human endurance plateaus: after 36–80 hours of continuous operations, alertness, reaction time and working memory degrade markedly. Beyond 80 hours, cognitive reasoning collapses and recovery is protracted (Susan Vrijkotte, 2016). In contrast, humanoids maintain peak performance as long as power is supplied. Biological warfighters plateau without specialized training; humanoids do not. Continued advances in materials science and precision manufacturing will further expand their capabilities.

2.3 Precision-Strike Potential

The humanoid robot is equipped with an advanced sensor array, including a high-resolution vision system, lidar, and inertial measurement unit, which can acquire and process environmental information in real time. Its mechanical structure is not limited by human physiology and can maintain an absolutely stable shooting posture. Under complex terrain conditions, the humanoid robot can also quickly adjust the shooting angle to maintain shooting accuracy without external interference. It is reported that the artificial intelligence "pilot" created by the US defense contractor Herron Systems swept a US Air National Guard pilot and a US Air Force Ordnance School graduate with 2,000 hours of F-16 fighter pilot experience with a record of 5 to 0 (Wang, 2023).

2.4 Reconfiguring Attrition Logic

Historically, warfare has been prohibitively costly. Intelligent weaponry is altering this calculus. Ukrainian sources report that Russia lost 28 801 UAVs between 24 February 2022 and 11 March 2025—its single largest category of materiel losses (Oleniak, 2025). On 25 December 2024, the Russian Ministry of Defence stated that Ukrainian forces had destroyed >38 500 UAVs since hostilities began (Афонин, 2024). In the age of intelligent munitions, materiel losses increasingly substitute for human casualties. Unlike expendable UAVs, humanoids are being designed for self-repair and recyclability (Wang P., 2025). Consequently, suicide missions are not their doctrinal centrepiece and reused.

They can instead be attrited, refurbished and redeployed. Such low-cost attrition dramatically compresses the marginal cost of conflict. Yet formidable technical and ethical hurdles remain. Capability gains hinge on iterative advances in the hardware–algorithm–data nexus. Critical constraints include joint degrees-of-freedom ceilings and algorithmic fidelity. These factors directly condition battlefield effectiveness and scalability. Nevertheless, their battlefield debut will indelibly rewrite the grammar of war.

3. Implications for Warfare

The ongoing militarization of artificial intelligence poses risks in at least three areas: first, when algorithms control weapons engagements, the behavior of artificial intelligence that relies on machine learning is difficult to predict, which means that they may react too quickly when erroneous behavior occurs, making it impossible for humans to intervene; second, the arms race involving major powers will intensify and bring structural risks to the international relations system; third, the weaponization of artificial intelligence will undermine the existing peace and security architecture (Garcia, 2023). The weaponization of humanoid robots will exacerbate these risks and create new problems.

Traditional warfare is a system built around humans. The number, quality, organization, weaponry, logistics, training, and human-designed tactics of these humans determine victory or defeat. Human-related resources such as food, land, education, institutions, and technological advancements all contribute to national power. Humanoid robots, with their "humanoid" and "superhuman" characteristics, will profoundly alter the very nature of warfare, completely overturning traditional battlefield models, military systems, and the very logic of power.

When the war game is completely changed, no country in the world will sit idly by. They will do their utmost to maintain their own safety through various methods. Ultimately, somewhere, conflicts caused by the security dilemma are bound to emerge among political units of power (Herz, 2003).

3.1 Obsoleting Human-Wave Tactics

For traditional warfare, "human wave tactics" is a basic feature of war. In the approximately 14,500 armed conflicts recorded by historians, about 3.5 billion people died (Arrequin-Toft, 2018). On average, each conflict resulted in the deaths of approximately 240,000 people, including soldiers, civilians, and laborers. Advances in weapon technology during World Wars I and II drastically increased casualties, with World War I resulting in over 35 million soldiers and civilian casualties, and World War II exceeding 70 million, demonstrating the devastation of these conflicts. War also tests a nation's logistical capacity. For example, treating the wounded on the battlefield requires specialized medical equipment, personnel, and supplies (White, 2009). As humanoid robot technology matures, it will be easy to produce humanoid robots as machines that can be produced on an assembly line. Elon Musk has set a goal to deploy thousands of Optimus Prime robots in Tesla factories by the end of 2025, and envisions expanding production to millions of units per year within four years (Zhou, 2025). With the improvement of industrial capabilities, scenes similar to the rapid "explosion of troops" in a short period of time in war games will become a reality.

In this way, for some populous countries, the absolute advantage of human resources has been erased. Along with it comes the thirst for technological upgrades, where small countries try to compensate for their shortage of manpower while large countries strive to maintain their advantage. Both big and small countries will be forced to get involved in the unnecessary competition of 'one mountain is higher than another'. The very character of the security dilemma is one of tragedy, since the

incompatibility the participants perceived to exist was illusory; the participants' intent was benign (Collins, 2004).

3.2 Humanoid Robots Will Change the Rules of War Attrition

Humanoids eliminate second-order costs—most visibly, compensation for fallen soldiers. US law entitles bereaved military families to a tax-free death gratuity of US$100 000, irrespective of cause (Military Compensation and Financial Readiness, 2007). Chinese regulations provide survivors with a lump-sum pension equal to 20 times the previous year's urban per-capita disposable income plus 40 months of the deceased's salary, adjusted for decorations (Regulations on Military Personnel Pensions and Benefits, 2019). These sums are fiscally significant. Conflict therefore imposes dual burdens: fiscal pressure on the state and psychological trauma on families. Conversely, humanoid combatants are valued far below human life. Furthermore, biological warfighters incur post-traumatic stress disorder, survivor guilt and moral injury (White, The Fruits of War: How Military Conflict Accelerates Technological Innovation, 2009). Modern combat intensity increasingly exceeds human biological limits. This erodes combat effectiveness and bequeaths long-term social pathologies.

Intelligent weapons invert cost–benefit ratios, offering "low-in, high-out" asymmetries. Testifying before Congress on 8 April 2025, General Bryan Fenton observed that the United States expends multi-million-dollar interceptors against US$10 000 one-way drones. "The cost curve is upside-down," he concluded (Li Z., 2025). This severs the historical nexus between force size and deterrence, enabling weaker actors to achieve asymmetric "small-wins-big" outcomes. Attackers can thus transcend conventional force ratios, compelling defenders to inflate expenditure. Consequently, the offence–defense balance is being reshaped, rendering intelligent-battlefield dynamics increasingly opaque. The imbalance between offense and defense exacerbates the panic of the international community, and the racial and geopolitical conflicts in the old international system will be amplified. The anxiety caused by asymmetry will lead to more uncertainty.

Technological trajectories therefore portend humanoids as the dominant battlefield force. Industrial throughput will supplant human resources as the decisive variable. This prospect constitutes a systemic revolution in warfare. Traditional manpower mobilization and training regimes will cede to industrial production lines. Logistics will pivot from blood and medics to spares and maintenance bots. Decision cycles will compress, offensives will accelerate, and synchronized operations will transcend geographical constraints.

4. The Impact of Humanoid Robot Weaponization on the International System

Anarchy creates a self-help system, which leads to security dilemmas. The only way for a country to respond to security dilemmas is to adopt policies of power politics, resulting in endless power competition and conflicts of interest (Qin, 2001). Humanoid weaponization will rewrite the rules of war and recalibrate individual, national and global security, thereby transforming the international system. Such substitution engenders multidimensional human alienation.

4.1 Risk of Physiological Alienation

From a physiological point of view, weaponized humanoid robots will lead to a decline in human decision-making ability, and algorithms will generally replace human commanders, resulting in "people becoming machines", and the increasingly "dull and demented" alienated situation will show an "escalating" trend (Sun, 2020). With humans absent from the battlefield and no longer needed for logistical support, war will remove humans from the equation, significantly impacting their organizational and coordination abilities. As humans transition from being the subject of war to the object of it, we may suffer from a collective "new type of war degeneration."

4.2 Risk of Psychological Alienation

American philosopher Don Eade believes that although the use of technology can enhance certain human abilities, it will inevitably narrow certain human perceptions. This is the "price" of humans using technological mediation (Eade, 2012). When humans use humanoid robots to wage war without restraint, considering that the casualties on both sides are robots, war will no longer be tinged with sadness, and over time, humanity will become morally blunted towards war. The Stanford Prison Experiment reveals that under the influence of hostile environments (such as prisons), those in power can do whatever they want to the powerless without fear of retaliation—a hostile environment that can even corrupt normal, educated, and healthy people (Bekiempis, 2015). Furthermore, when a fully humanoid robot can replace humans in every aspect, the "uniqueness" of humans will be challenged, and their own vulnerability will be infinitely magnified, leading to doubts about their own existence. The holders of technological power are at risk of abusing their power. Those who have the greatest influence on AI regulation are prone to abuse their power, while those with the most relevant interests have no ability to check and balance power (Simon, 2023). Situational forces can transform normal, decent people into perpetrators of evil. The weaponization of humanoid robots will lead to differentiated risks for individuals and create dilemmas in technological control.

4.3 Risk of Ethical Alienation

From an ethical perspective, technology is a manifestation of human power and a form of action, and all human actions are subject to moral scrutiny [From an ethical perspective, technology is a manifestation of human power and a form of action, and all human actions are subject to moral scrutiny]. The unique characteristics of AI have led to AI weapons exacerbating the complexity of warfare, pushing it further out of human control. When weaponized humanoid robots engage in unethical behavior, such as accidentally injuring civilians on the battlefield, ethical questions arise: who should be held accountable? Traditional accountability systems are ill-equipped to address this situation. This is because the "decision-maker" is not a single person but an autonomous AI system, influenced by developers, data scientists, users, and even other AI systems, and shaped by their own learning processes (Floridi, 2024). As for the attack methods of humanoid robots, it is attributed to algorithms rather than morality. AI-driven decision-making is a black box and has nothing to do with morality or not (Wang

X., 2020). Regulators, therefore, face a dilemma. On the one hand, the international structural competitive pressures brought about by the development of AI compel those in power to vigorously develop relevant technologies in order to meet competitive challenges from other countries. If, under pressure, those in power tend to adopt a "technical irresponsibility" approach, this risks ethical disorder.

4.4 Intensifying Interstate Competition

Humanoid weaponization will spawn novel national-security dilemmas. Like tanks, carriers and atomic bombs before them, mature humanoid weapons will rapidly widen military power differentials. Technological primacy will confer decisive overmatch, obsolescing legacy countermeasures. Security-dilemma dynamics render military lag intolerable. Even mutually defensive actors cannot be sure of each other's future intentions. Preventive fears thus proliferate. A vicious arms spiral ensues. Offence–defence imbalance may revive preventive-war logics, jeopardizing national security. Humanoid weaponization demands formidable composite national power. At present, only China and the United States possess end-to-end industrial ecosystems; others lag far behind. The United States has formally launched dedicated programmes. The U.S. National Security Commission on AI warns that failure to accelerate adoption could forfeit U.S. military-technological superiority within a decade." It therefore urges the Pentagon to pursue organizational reform, novel operational concepts, quantified AI-readiness targets and a unified battle-network architecture. The U.S. government has outlined plans for a 100 000-strong humanoid force. Spearheaded by start-up Figure AI, the project envisions multifunctional humanoids across strategic domains (AI Blog, 2025).

China's 2023 Guiding Opinions on Humanoid-Robot Innovation targets an initial ecosystem by 2025. The roadmap emphasizes breakthroughs in "brain–cerebellum–limb" technologies to secure resilient component supply chains. By 2027 Beijing aims for a secure, reliable and internationally competitive industrial ecosystem. Large-scale diffusion across civilian and military sectors is projected to become a new engine of economic growth. Sino-U.S. duopolistic competition is therefore foreseeable. Concomitantly, demand for critical minerals—especially rare-earth elements—will intensify.

4.5 Asymmetric Polarization

On the other hand, the widespread penetration of AI into the political, economic, and military spheres plays a crucial role in achieving the "cross-domain integration" required by "integrated deterrence," contributing to the more comprehensive development and integration of deterrence capabilities in both military and non-military fields. The advantages of humanoid robots, such as low cost and "human substitution," will strengthen the deterrent's perception of deterrence, thereby enhancing the credibility of deterrence. [Zhang Huang and Du Yanyun: "Military Intelligence and the Generative Path of AI Deterrence," Diplomatic Review, No. 1, 2025, p. 101.] In the face of technological asymmetry, the search for new asymmetric warfare methods will become the primary development direction for the militaries of small and medium-sized countries or weaker armed groups. Therefore, the military security of the international system will develop in two extreme directions: major

powers will fully strengthen the development of AI weapons, striving to establish a new deterrent force and safeguard national security. Small countries will focus on building asymmetric forces based on AI technology and establishing a new offensive and defensive balance. The weaponization of humanoid robots will further exacerbate this asymmetric polarization trend, causing national security to remain in a state of tension and reducing the controllability of war. In addition, as the technology of humanoid robot weaponization matures, the lack of capabilities of small countries will prompt them to seek protection from big countries. The specific methods may be to integrate into the humanoid robot industry chain of big countries through division of labor and cooperation to achieve technology acquisition; or to directly obtain military products through arms sales system, quasi-alliance construction, etc.; or they may join forces to build a new industrial chain structure. The EU may take this path.

4.6 Intensifying Non-Traditional Security Threats

In the non-traditional security sphere, the increasing intelligence of weapons will increase the threat of terrorism. From a narrative threat perspective, the CIA indicates that drone strikes appear to encourage terrorism and increase support for local violent extremist groups. This appears particularly true in the absence of supporting narratives and legitimacy, allowing terrorists and extremist groups to exploit civilian deaths to advance their propaganda and recruitment efforts. A 2020 study found that terrorists are more likely to increase attacks in the months following a lethal drone strike (ProCon, 2025). In addition, non-state actors can use drones, network tools, and advanced communication systems to conduct military operations and military strategies that only state actors can carry out. Terrorists can use advanced intelligent weapons to launch terrorist attacks. Between 1994 and 2018, there were more than 14 terrorist attacks planned or attempted using aerial drones. Terrorist organizations used intelligent weapons to carry out a series of activities including intelligence collection, explosive delivery, and chemical weapons delivery (Thomas, 2021). The development of new technologies will lower the threshold for terrorism, posing a severe challenge to national security. With the advancement of humanoid robotics, non-traditional security issues will be further exacerbated. Terrorists will use the latest humanoid robots as tools to carry out terrorist attacks. The commercial and social nature of humanoid robots will facilitate terrorist attacks.

5. Conclusion

In sum, humanoid-robot weaponization will reconfigure global power. States mastering core technologies will accrue disproportionate military leverage. This leverage translates into rule-making authority, institutional creation and reform—potentially catalyzing systemic power shifts. AI gaps may incentivize dominant powers to instrumentalize governance institutions. Hegemonic actors will seek to perpetuate supremacy through generational technological leads, triggering reactive arms racing. The resultant digital divide will entrench “winner-takes-all” dynamics, deepening global instability (Qi, 2024). Given that current producers are all major economies, weaponization appears inevitable. A

widening technological chasm will therefore magnify inequality and strategic uncertainty. The cruel reality is that AI weaponization is inexorable. Its dual-use nature, ease of diffusion and potential destructiveness render AI weaponization uniquely perilous. The international community must urgently craft binding AI governance and ethical norms. Leading powers have begun preparatory measures. The U.S. NSCAI advocates (1) reaffirming human-only nuclear release authority and obtaining reciprocal pledges; (2) establishing crisis-stability dialogues; and (3) codifying international standards for AI and autonomous weapons (Final Report, 2021).

As one of the leading countries in the humanoid robot industry, China is seeking broad consensus on the risk of humanoid robot weaponization and working with other countries around the world to build a governance platform for the weaponization of humanoid robots. In addition to actively building a global governance system, China is also vigorously developing humanoid robot technology. Faced with dramatic changes in the internal and external security environment, China is constantly adjusting its security planning and building a national security concept that keeps pace with the times. This is a shift from a traditional security concept centered on political security and primarily implemented through military security to a comprehensive national security concept that prioritizes the security of the people and relies on cooperation and dialogue (Ling & Yang, 2019).

The issue of weaponization brought about by technological innovation is a long-term problem. The anxiety of other countries caused by this fluctuation is inevitable under the rule of anarchy. Even the need for self-protection can be seen as a threat by other countries. Once the amplification of contradictions and conflicts is misjudged, wars will follow one after another. The international community should establish a trust mechanism to prevent and resolve crises, and think about the future path of humanity.

The history of human development shows that humanity has progressed from primitive society through the agricultural revolution, the industrial revolution, and the information revolution. However, no matter how productivity has advanced, one fundamental reality has not changed: Earth is humanity's only home. All countries have a shared responsibility to protect the planet and safeguard humanity's future. If we engage in vicious competition or even war for power and profit, we will ultimately end up on a path of self-destruction (The Xinhua News Agency, 2023). The realization of this governance approach depends on the adherence to human values. Especially in today's rapidly developing humanoid robot technology, the country should establish a people-oriented legislative concept and construct technical regulations to ensure human survival, enhance human welfare, and promote the all-round development of people. Only by standing together and helping each other can countries avoid being destroyed by the wave of new technologies.

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Availability of Data and Materials

The authors confirm that all data generated or analysed during this study are included in the published articles in the references.

Conflicts of Interest

The authors declare that they have no conflicts of interest to report regarding the present study.

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