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# Robotics and the Changing Characteristics of Warfare

Harjeet Singh

Since the dawn of the 21st century, in the wake of technological developments and the miniaturisation of powerful computing capabilities, the use of unmanned systems and robots has greatly increased in a variety of fields: in industry, medicine, transportation, and in the home. On the battlefield, there has been a significant increase in the use of unmanned systems, mostly aircraft, in warfare. These tools do not always meet the accepted definition of “robots,” but there is often a failure to distinguish between them. While some disagree on a concise explanation, one definition of an unmanned platform is “an air, land, surface, sub-surface, or space platform that does not have the human operator physically onboard.”<sup>1</sup> A robot is also an unmanned platform, but in order to fit the definition of a robot, a system must have three key components: sensors, processors and effectors.<sup>2</sup> These components allow the robot a certain amount of autonomous action. This is in contrast to an unmanned platform that may need an operator and is not capable of any independent activity in a changing environment.

The trends that enable proliferation of autonomous systems are also part of their inherent risk. The lower cost and greater availability of technologies enable any person to purchase systems or assemble them using purchased components, with the potential to inflict serious damage. Furthermore, these technologies and systems have dual use, civilian and

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military, and are easily converted from one to the other as they are computer-based. This creates a real difficulty in placing restrictions on their use, significantly increasing their hazardous potential. In the present era of warfare, robotic tools are capable of using lethal force and taking human life autonomously, without human intervention. Unmanned systems, and robotic

systems in particular, are playing an increasingly large role in military forces, and they will continue to develop in a variety of fields.

The ethical and moral questions raised by the use of armed autonomous systems grab much attention today. Those leading the campaign to limit or outlaw their use are mainly human rights organisations. Their focus on harm to civilians diverts the discussion from even greater risks. Countries that impose restrictions on themselves voluntarily, whether by means of internal directives or by multi-state agreements that lack an enforcement mechanism, perhaps soothe public opinion in the short term, but they adversely affect the chances of preemptive, in-depth treatment of this issue for the benefit of all humanity. An in-depth discussion on the future effects of robotic technologies on humanity is necessary in order to cope with the risks and enjoy the benefits. Current arms control tools are not suited to the age of robotics, an age that is no longer in the realm of science fiction.

### **Defining a Robot**

The neologism of the word ‘robot’ is derived from the Czech noun ‘*robota*’ meaning ‘labour.’ It has several taxonomies:

- **Control Taxonomy**
  - (i) Pre-programmed (automatons, i.e. a mechanism that can move automatically).
  - (ii) Remotely-controlled (telerobots, i.e. the area of robotics that is concerned with the control of robots from a distance).

(iii) Supervised autonomous (i.e. existing as an independent entity).

Autonomous.

- **Operational Medium Taxonomy**

- (i) Space.

- (ii) Air.

- (iii) Ground.

- (iv) Sea.

- (v) Hybrid.

- **Functional Taxonomy**

- (i) Military.

- (ii) Industrial.

- (iii) Household.

- (iv) Commercial.

The emerging robot is a machine with sensors, processors and effectors, able to perceive the environment, have situational awareness, make appropriate decisions, and act upon the environment. These are:

- Sensors: active and passive optical and radar vision, acoustic, ultrasonic, Radio Frequency (RF), microwave, touch, etc.
- Effectors: propellers, wheels, tracks, legs, hybrids.
- Control system architectures: deliberative, reactive, hybrid.
- Command, control, and communications systems: cable, fibre optic, RF, laser, acoustic.
- Human/machine interfaces: displays, tele-presence, virtual reality.

Military unmanned vehicles are robots, used in different dimensions: space, air, ground, water; and varied taxonomies have been used for robotic air, ground, and water vehicles, based on their size, endurance, mission, user, Command, Control, Communication (C3) link, propulsion, mobility, altitude, level of autonomy, etc.

## **The Robotic Revolution**

Wars have been a part of human life since pre-historic times and they are expected to play an important role in the future also. The shape, characteristic, and size of wars have changed drastically over time due to transformations in societies. The changing circumstances unavoidably affect the characteristics of warfare, for instance, its motivations, shape, and size. Armies have adapted themselves to these changing characteristics of warfare through what is called the “Revolution in Military Affairs” (RMA) by introducing new military concepts and technologies. There have been times when new technologies enabled Armies to develop new war concepts; and times when new concepts required the development of new technologies. In both cases, Armies have aimed to adapt themselves to changing characteristics of warfare through military technology.

Unmanned tools have a variety of advantages. Among these are the fact that they reduce and sometimes even eliminate the risk to a human being in carrying out an action; they are usually more accurate than their manned counterparts; and, in some cases, because their operation does not entail a physical or physiological burden, they make possible a variety of actions that could not be carried out in the past by means of manned systems. Their many advantages have led to their increased use; a prominent example is the increase between 2005 and 2012 in the number of countries employing unmanned aerial vehicles, from 40 to more than 75.<sup>3</sup>

The United States (US) is at the forefront of increased use of unmanned platforms on the battlefield, some of them robotic, and has deployed a large number of such systems over the past two decades. Their use is especially prominent in air warfare against terrorist organisations in Afghanistan, Pakistan, Iraq and Yemen, where unmanned aerial vehicles have been used extensively for missions of surveillance, intelligence gathering, and attacks on targets on the ground. In 2010, the US possessed 12,000 unmanned ground systems and more than 8,000 unmanned

aerial vehicles.<sup>4</sup> In the same year, the ratio of robots to US troops in the battlefield in Afghanistan was 1:50 (one robot to every 50 soldiers), and it has been reported that it is likely to rise within a few years to 1:30.<sup>5</sup>

Notwithstanding this significant increase, the use of unmanned platforms is not free of ethical dilemmas and issues, particularly in regard to remote operation that is risk-free for the operator. The

ethical question their use raises is whether it is appropriate to fight with such extreme asymmetry, with one side exposed and vulnerable in the battlefield, and the other side striking from a remote and protected position? Questions concerning the use of autonomous systems that operate without any human involvement and that can cause loss of human life are even more complex. There are those who claim that such actions are not fair or dignified, and it is cowardly to attack the enemy from a protected location, whether with planes or submarines or unmanned systems. However, according to international law, these are not illegal acts.<sup>6</sup>

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### **The Issue of Autonomy**

Autonomy in unmanned systems is the ability of a system to carry out a task independently, without human intervention, and can be divided into four main levels:

- systems that are remotely, but completely human-operated and are, therefore, not autonomous at all;
- systems capable of carrying out very specific operations relatively independently;
- systems capable of performing a variety of activities independently, under human supervision; and

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- systems that, barring initial activation, are completely independent and do not require the intervention of a human operator to carry out their mission (although a human operator can intervene and influence events if necessary, e.g., by ordering that the mission be aborted).<sup>7</sup>

Of the elements that define a robot, what, in fact, enable autonomous activity more than anything else are the computing capabilities of the computer processor. Algorithms (computerised instructions on how to perform a task or tasks) are usually responsible for the actions of an autonomous system. Software-based, this capability is fundamentally a cyber (computational) capability, and in a world of cyber threats, there is a risk of its being stolen or hacked into or disrupted as a result of a malfunction. Nevertheless, when tools are developed by serious companies under the supervision of the countries ordering them, we can rationally assume that the required steps are taken to protect them from possible threats, although malfunctions do sometimes occur.<sup>8</sup>

Most of the systems in use today in the service of modern Armies are autonomous to a limited extent only and a high level of human intervention is needed to operate them. For example, the US *Predator* (an unmanned aerial vehicle), used for attacking targets on the ground (since 2012, mainly in Afghanistan), controls and supervises landing, take-off, and time in the air with a certain level of autonomy. However, planning of the mission, identification of the target, and the attack itself are guided and controlled by a human operator from a control room on the ground (located usually within the US, while the aircraft flies in another country). While most military unmanned systems today are remotely controlled,

there is a limited number of completely autonomous systems that have the ability to choose their targets independently, without human intervention. Examples of the latter include the American *Patriot* and the Israeli *Iron Dome*, anti-missile defence systems that identify their targets independently and use algorithms to calculate independently the most effective way to strike. (These systems raise almost no objections, apparently because they do not operate against human beings.) There are very few such systems active in the battlefield today, and most of them actually require the approval of a human operator to carry out an action.

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In contrast, most autonomous systems choose targets by identifying movement, heat, or other relatively simple parameters. Thus, for example, using heat and motion sensors, South Korean robots in the demilitarised zone between South and North Korea can identify and shoot people without human intervention.<sup>9</sup> Most of these systems are able to be more selective in choosing their targets than, for example, landmines, which make no distinction between targets, and, therefore, are prohibited by the United Nations Convention on the Prohibition of the Use, Stockpiling, Production, and Transfer of Anti-Personnel Mines and on their Destruction, which has been signed by 139 countries.<sup>10</sup> Likewise, unmanned aerial systems are considered to be different from missiles, even guided missiles, mainly because they can be used more than once, but also due to their ability to be selective about targets.

According to publications on this topic, lethal autonomous robots exist today in the US, Israel, South Korea, and Great Britain, and will soon be used by technology leaders such as China and Russia.<sup>11</sup> These systems evoke the greatest opposition by human rights groups and other

organisations, which object to the use of robots in the battlefield and are at the forefront of the struggle to ban their use. With futuristic warfare in mind, India is also working to develop robotic soldiers as part of efforts to boost unmanned fighting capabilities, joining a select group of countries in this endeavour. Under the project being undertaken by the Defence Research and Development Organisation (DRDO), robots would be developed with a very high level of intelligence to enable them to differentiate between a threat and a friend. These can then be deployed in difficult warfare zones like the Line of Control (LoC), a step that would help avert the loss of human lives.<sup>12</sup>

### **International Humanitarian Law and Ethical Issues**

The science fiction author Isaac Asimov, mentioned the Three Laws of Robotics, in his 1942 short story *Runaround*. These are:<sup>13</sup>

- A robot may not injure a human being or, through inaction, allow a human being to come to harm.
- A robot must obey any orders given to it by human beings, except where such orders would conflict with the First Law.
- A robot must protect its own existence as long as such protection does not conflict with the First or Second Law.

The Three Laws have pervaded science fiction and been referenced in many books, films and other media and have often been the base from which artificial intelligence discussions about how robots and humans will interact in the future have grown. However, the Three Laws are not completely appropriate for future robotic constraints but rather that their basic premise, to prevent robots from harming humans, will ensure that robots are acceptable in their actions to the general public. These laws are now being given the go-by in their military use, raising several issues. A major International Humanitarian Law issue is that autonomous armed robot systems cannot discriminate between combatants and non-

combatants or other immune actors such as service workers, retirees, and combatants who are wounded, or have surrendered, or are mentally ill in a way that would satisfy the principle of distinction. There are systems that have a weak form of discrimination. For example, the Israeli *Harpy* is a loitering munition that detects radar signals. When it finds one, it looks at its database to find out if it is friendly and if not, it dive bombs the radar. This type of discrimination is different from the requirements of the principle

of distinction because the *Harpy* cannot tell if the radar is on an anti-aircraft station or on the roof of a school.

Robots lack three of the main components required to ensure compliance with the principle of distinction. First, they do not have adequate sensory or vision-processing systems for separating combatants from civilians, particularly in insurgent warfare, or for recognising wounded or surrendering combatants. All that is available to robots are sensors such as cameras, infrared sensors, sonars, lasers, temperature sensors, radars, etc. These may be able to tell us that something is a human, but not much else. (There are systems in the labs that can recognise still faces and they could eventually be deployed for individual targeting in limited circumstance. But how useful could they be with moving targets in the fog of war or from the air? (British teenagers beat the surveillance cameras simply by wearing hooded jackets).

Second, a computer can compute any given procedure that can be written down in a programming language. This is rather like writing a knitting pattern or recipe. We also need to be able to specify every element

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in sufficient detail for a computer to be able to operate on it. The problem for the principle of distinction is that there is no adequate definition of a civilian that can be translated into computer code. The laws of war do not provide a definition that could give a machine the necessary information. The 1949 Geneva Convention requires the use of common sense, while the 1977 Protocol I defines a civilian in the negative sense as someone who is not a combatant.

Third, even if machines had adequate sensing mechanisms to detect the difference between civilians and the uniform-wearing military, they would still be missing battlefield awareness or common sense reasoning to assist in discrimination decisions. We may move towards having some limited sensory and visual discrimination in certain narrowly constrained circumstances within the next 50 years. However, human-level discrimination with adequate common sense reasoning and battlefield awareness may be computationally intractable. At this point, we cannot rely on machines ever having the independent facility to operate on the principle of distinction as well as human soldiers can. There is no evidence or research results to suggest otherwise.

Another issue is that robots do not have the situational awareness or agency to make proportionality decisions, i.e. minimising collateral damage by choosing the most appropriate weapon or munition and directing it appropriately. There is a software called *bugsplat* used by the US military for this purpose. The problem is that it can only ease collateral impact. For example, if munitions were used near a local school where there were 200 children, the appropriate software may mean that only 50 children were killed rather than all had a different bomb been used. The hard proportionality problem is making the decision about whether to apply lethal or kinetic force in a particular context in the first place. What is the balance between loss of civilian lives and expected military advantage? Will a particular kinetic strike benefit the military objectives or hinder them because it upsets the local population? The list of questions is endless. The

decision about what is proportional to direct military advantage is a human qualitative and subjective decision. It is imperative that such decisions are made by responsible, accountable human commanders who can weigh the options based on experience and situational awareness. When a machine goes wrong, it can go really wrong in a way that no human ever would.

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Finally, there is the issue of accountability. A robot does not have agency, moral or otherwise, and consequently cannot be held accountable for its actions. Moreover, if autonomous robots were used in limited circumstances in the belief that they could operate with discrimination, it would be difficult to decide exactly who was accountable for mishaps. Some would say that the commander who gave the order to send the robot on a mission would be responsible (last point of contact). But that would not be fair since it could be the fault of the person who programmed the mission, the manufacturer who made the robot, or the senior staff or policy-makers who decided to deploy it. Or it could be claimed that the device was tampered with or damaged.

### **Operational Advantages of Robotics on the Battlefield**

War is a deadly and hazardous endeavour. Throughout history, the willingness to take risks with bold, daring actions has often proved decisive. Those who have dared to undertake risky, seemingly impossible missions have caught their enemy off-guard, often with spectacular results. Unmanned systems can not only save human lives by undertaking dangerous missions in their place, they can enable new concepts of operation that would not be possible were human lives at risk.

**Counter-mine Operations:** Just as ground robots have proved tremendously useful in countering improvised explosive devices on land,

the US Navy is investing in unmanned surface and underwater vehicles for countering sea mines.<sup>14</sup> One promising avenue for further exploration is the use of robotics for counter-mine amphibious operations. Deployed from unmanned underwater vehicles, submarines or surface boats, amphibious robots could find and clear beach obstacles and mines prior to the arrival of amphibious assault troops. Once ashore, robots could establish a perimeter and act as scouts and sentries for the amphibious assault itself.

**Expendable Scouts:** Because of their ability to take risks, robotic systems can be used as expendable scouts for a wide range of missions. Air and ground robots can scout ahead for ground troops, amphibious and undersea robots can provide pre-assault mapping and scouting of beaches, and small expendable unmanned air vehicles can provide immediate battle damage assessment of strikes. If communication links are assured, unmanned systems can be sent on one-way suicide missions into enemy strongholds to draw out enemy defences and send back valuable information as they perish.

**Decoys, Deception and Defence:** The Miniature Air-Launched Decoy (MALD) is an example of what is possible with expendable unmanned systems. Not quite an aircraft and not quite a munition, the MALD is a small loitering air vehicle that is launched from a fighter aircraft. It flies ahead of human-occupied fighters, emitting signals in the electromagnetic spectrum to deceive enemy radars into thinking it is a fighter. When enemy radars give away their position by attacking the decoy aircraft, the real fighters pounce.<sup>15</sup> Expendable decoys can draw out enemy defenders and redirect the enemy against decoy targets, which increases the survivability of human-occupied vehicles and encourages the enemy to waste munitions. Unmanned vehicles can serve as valuable decoys in a variety of settings. Unmanned ground vehicles can undertake feint manoeuvres to confuse enemy forces.

**Stand-In Jamming and Electronic Attack:** In addition to serving as scouts and decoys, unmanned air vehicles can perform electronic attack

missions, such as radio-frequency jamming and delivering high-powered microwaves. Because the disruptive effect on a target from an electronic attack is a function of both power and distance, unmanned vehicles are particularly attractive for this mission; their reduced size and greater ability to take risk means they can get close to a target, where lower power is needed. Unmanned aircraft can be used not only to jam and suppress enemy air defences, but also to destroy them.

**Casualty Evacuation:** Casualty evacuation is an attractive mission for unmanned vehicles. Almost by definition, casualties are likely to occur in dangerous areas, and human evacuation missions run the risk of additional casualties. Unmanned vehicles could be used to extract the wounded from dangerous areas and evacuate them to safety without risking additional lives. Future capabilities by unmanned systems could include casualty evacuation and care, human remains evacuation, and urban rescue. Several nations are developing dedicated casualty evacuation unmanned aircraft to save their wounded.<sup>16</sup>

**Clandestine Reconnaissance and Sabotage:** Because of their ability to take more risks, robots could be sent deep behind enemy lines, not just as scouts but also for intrusive intelligence-gathering and sabotage. Stealthy unmanned aircraft can be used for clandestine reconnaissance without risking a major fallout. While in the event of a shoot-down or crash, a highly sophisticated aircraft would not be plausibly deniable, small cheap robots could be, if they were made from commercial off-the-shelf components and without identifying markings.

Bird-like drones could “perch and stare” at possible targets. Long-endurance surface vessels could patrol an enemy’s coastline, gathering valuable intelligence. Robotic snakes could swim up enemy rivers, across beaches onto land and even into enemy facilities. Using visual-aided navigation independent from Global Positioning Systems (GPS), air-mobile robots could fly down the air shafts of hardened and deeply buried facilities to map out targets.<sup>17</sup> Novel, transforming

robots could alternately swim, fly and crawl as needed.<sup>18</sup> Persistent robotic systems could wander and feed off enemy infrastructure, tapping into wireless networks and power lines to send encrypted messages and draw power. Robotic systems could be used to tag, track and locate enemy targets. Unattended ground sensors, deployed from other clandestine air and ground robots, could watch key roads and facilities. Small, hummingbird-size air-mobile drones could embed themselves into mobile missile launchers. “Hull crawling” robots could attach themselves to enemy ships and submarines. These tiny robots could periodically send short transmissions of the enemy vehicle’s location or could wait passively for a signal from other assets before responding. Such systems could also be used to seed the battlefield before an attack. On order, they could spring into action, delivering kinetic or non-kinetic electronic warfare or cyber payloads to sabotage enemy systems.

### **Rationale for Robots**

In summation, robots are eminently suitable for tasks that are hot, heavy and hazardous as well as dull, dirty and dangerous. They are ideal for the increasing lethality of warfare because of the advantages of:

- No casualties or prisoners.
- No high attrition of expensive manned systems.
- Reduced public backlash.
- Flexibility to counter terrorist, insurgent, and tribal warfare.

Robots are a viable proposition for the military in view of increasing personnel costs and the changing geo-political climate, and proliferation of weapons of mass destruction which could render large areas toxic and uninhabitable, and obviate the need for protective garments which limit human efficiency and effectiveness. The use of robots would eliminate the need to encase and protect humans in

vehicles, thus, making them smaller, lighter, and less expensive. They could be expendable and ideal for suicide missions. They would also be more survivable due to their small signature; more manoeuvrable by moving faster, with higher acceleration; capable of faster response times. The riskier manoeuvres and tactics are possible to be developed without the fear of casualties. Robots would be fearless and aggressive, not deterred by near misses; they would be indefatigable, with no need for sleep or rest. In the autonomous modes, fewer personnel can supervise more systems; and could reduce the costs of warfare.

### **Integration Challenges**

The integration of semi-autonomous combat robots will require a comprehensive effort to address the wide ranging changes from this advanced technology. Fielding semi-autonomous combat robots, like any new technology, without its effective integration, will run the risk of disrupting the military as a force. The initial development considerations are numerous and go from the strategic down to the tactical level. The list includes the following, but is not inclusive:

- What would be the ratio between manned and semi-autonomous combat robot systems?
- How would the military sustain semi-autonomous combat robot systems requiring increased maintenance and logistics?
- How would a semi-autonomous combat robot force train and deploy?
- How would a commander prevent a tactical success from becoming a strategic failure due to excessive damage and/or civilian casualties from a semi-autonomous combat force?
- Could semi-autonomous combat robot forces be allowed to repair themselves or update their own programming?
- Can concepts, doctrine and acquisition keep up with the technology revolution in semi-autonomous ground combat forces?

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## Conclusion

In recent decades, the use of drones has risen sharply. At the same time, only a few states use them. It is certain, however, that development in robotics for military use will lead to more countries facing the decision of whether to acquire armed and even autonomous robots. Unmanned systems can play a useful role in supporting troop operations. At the same time, there is a downside of unmanned systems: they cannot win a war. Basically, it is always, and possibly even more so now, a matter of boots on the ground. Moreover, there are several important ethical objections to using armed, unmanned systems.

All of the armed robots currently in use have a person in the loop to control their flight and to apply lethal force. But that is set to change soon. Over the last decade, the roadmaps and plans of the US have made clear the desire and intention to develop and use autonomous battlefield robots. Fulfilment of these plans to take the human out of the control loop is well underway. And the US is not the only country with autonomous robots in its sight. Others are following suit. The end goal is a network of land, sea, and aerial robots that will operate together autonomously to locate their targets and destroy them without human intervention. It is clear that there have been civilian casualties in operations involving armed drones. So far, an extensive analysis is lacking. It is also unclear what the legal implications of deploying drones are. Are drone operators a legitimate target? Does this expand the battlefield? What are the rules for the proliferation of robotic technology? There are also many questions about extra-judicial killings. Are they legal? If they are, are they effective? In other words, do they contribute to stabilising a conflict situation?

When considering using drones, it is important to take into account their ethical and legal implications and not just their practical military

pros and cons. This is not simply about technological progress, but a question of the responsible use of new technology. Unmanned warfare is not by definition a good idea. Responsible decisions must include a reliable assessment of the objections. States currently using drones must be more open about disclosing their use and their effects on the ground. How many civilian casualties do they inflict? How do civilians living in the areas where they are used perceive them? It is

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important for new weapon technologies to be validated against ethical and juridical principles before they are put to use. The deciding factor and core value must be whether or not deployment of new technology in combat improves human security. There must be a responsible balance between the safety of soldiers and the safety of civilians. The deployment of robots is much safer for soldiers, but do they benefit the civilians these soldiers are supposed to be protecting? Initial assessments against ethical and juridical principles suggest negative feelings about the deployment of armed or autonomous robots.

Armed unmanned systems satisfy a desire in our society to wage war without putting our own people at risk. This urge seems to be based on the misconception that wars can be waged clinically. Deploying robots and drones can make it easier to use violence, and that, in turn, can result in escalation of conflict. Humans must remain in control if they engage in warfare. They are the ones who must draft the interpretations and make the decisions. This must never be left to computers or computer-generated data. Unarmed and unmanned aircraft can help soldiers to distinguish better between combatants and civilians. But the footage and intelligence gathered are useful

only when they can be processed and interpreted. Continuous aerial surveillance without adequate interpretation or corroboration from other sources can lead to a one-dimensional approach to the complex situation on the ground. This approach also leads to more civilian applications and surveillance duties for drones while side-stepping discussions on their desirability and effectiveness.

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