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GROUND ROBOTICS IN MODERN COMBAT

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Introduction

The automation of military vehicles and systems has long been a feature of warfare, but the emergence and development of ground robotics are revolutionising modern combat. Since their deployment in conflicts such as in Afghanistan and Iraq, ground robots have evolved into increasingly capable and autonomous entities integrated into military operations (Rosenberg, 2024). Fuelled by recent conflicts such as the Nagorno-Karabakh conflict and the Russia-Ukraine War, which have highlighted the significant impact of military robotics on the battlefield, interest in the further development of this field continues.

The development of unmanned ground vehicles (UGVs) has proceeded slowly, with ongoing challenges and questions surrounding their integration into military operations and ground forces (Gosselin-Malo, 2023). This paper aims to outline the advancements in ground robotics, explore the rationale for their increased proliferation in warfare, outline potential challenges in their widespread integration, and briefly analyse the deployment of such ordnance in the ongoing Russia-Ukraine War.

Defining (Ground) Robotics

Robotic systems embody two crucial elements: (1) unmanned platforms or vehicles, and (2) autonomous or semi-autonomous operations (Scharre, 2014). While the former operate without human intervention, the latter are remotely operated by humans. Furthermore, Monckton (2018) reveals that since the beginning of the 21st Century, the utilisation of military robotics has gained momentum with the proliferation of unmanned aerial vehicles (UAVs), unmanned underwater vehicles (UUVs), unmanned surface vehicles (USVs), and most importantly for this paper UGVs. Robotics have spread across all military domains. Due to the many obstacles and challenges posed to robotics on land, there is a greater requirement for ground robotics to perform uninterruptedly (Neumann, 2021). This has prompted rapid advancements and competition for technological dominance in conflict zones.

Developments in Ground Robotics

The modernisation of military equipment has created an arms race for technological dominance termed the ‘robotics revolution’ (Scharre, 2014, p.5). The burgeoning market for robotics and autonomous systems engulfs a wide range of different sizes and capabilities to fulfil various functions. Focusing on ground robotics, they range from major machinery such as the U.S. Army’s XM30 and the Robotic Combat Vehicles (RCVs) in the US’s Next Generation Combat vehicle programme to throwable surveillance and reconnaissance robots (Rosenberg 2024). Even within RCVs, there are major differences. For example, the RCV Light (RCV-L) weighs more than 10 tonnes, with dimensions of roughly 224 x 88 x 94 inches; the RCV Medium (RCV-M) weighs between 10 and 20 tonnes, with dimensions of roughly 230 x 107 x 94 inches; and the RCV Heavy (RCV-H) weighs between 20 and 30 tonnes, with dimensions of roughly 350 x 144 x 142 inches (Congressional Research Service, 2023). These new technologies, both large and small, provide combatants with greater standoff distance from the enemy. This incentive to protect lives certainly propels the development of ground robotics.

The 'electronic miniaturisation' (Monckton, 2018, p.35) is another factor in the development of ground robotics in modern combat. The 'growing demand for smaller and more agile robots for urban warfare scenarios' (Report Prime, 2023) is mirrored in the plethora of small ground robotics available on the market. These include the TALON V, the Dragon Runner 20 (DR-20), the Avenger 2.0 Mid-Sized Robot, and the NEVRA S Reconnaissance Robot. To date, ground robotics have predominantly carried out search and rescue, surveillance and reconnaissance, mine clearance, and firefighting tasks (Jha, 2024; Rosenberg, 2023).

The ease with which these smaller UGVs can perform dangerous or unsuitable tasks for military personnel undoubtedly changes the character of warfare. Being equipped with advanced sensors and cameras, such as CBRN/HAZMAT sensors, in addition to Ground Penetrating Radars (GPR), smaller UGVs have a wide array of features and capabilities for providing military logistics ahead of troop deployment. Additionally, the increased automation allows individuals to process large amounts of data quickly, allowing combatants to react to events faster than their adversaries (Scharre, 2014). Moreover, the small size of these 'miniature' UGVs makes them extremely cost-effective and affords the ability to procure larger numbers of systems.

Similarly, combining large ground vehicles with robotic appliqué kits allows armies to leverage older military vehicles and continue automating military ground vehicles. The U.S. Army's High Mobility Multipurpose Wheeled Vehicles (HMMWVs) and M113 armoured personnel carriers (APCs), which cannot be utilised in conflicts due to insufficient protective armour, can be developed into a UGV with the application of a robotic appliqué kits (Scharre, 2014). These kits comprise sensors and command systems applied to existing vehicles to convert them into autonomous vehicles, thereby reducing potential human casualties. Combining two recyclable components allows for augmenting robot ground forces at minimal costs.

The growing capabilities of autonomous robotics due to Artificial Intelligence (AI) means ground robotics are becoming increasingly capable of performing missions on the battlefield alongside humans. This could increase the global number of UGVs from the present 15,000 to 40,000 by 2030 (maris-tech, 2023). Armies including Germany and Britain incorporating UGVs like Ziesel and Type X into training, collaborative exercises involving drones and UGVs such as Viking being undertaken by the U.S., the UK, and Australia, and countries like the Czech Republic and Spain actively developing systems such as the Taros and SR-0001, illustrate this upward trend (Gosselin-Malo, 2023). Despite militaries augmenting combat training with UGVs, however, robotic combat is far from achieving full autonomy.

Challenges and Hurdles in the Proliferation of Ground Robotics in Combat

Tucker and Williams (2022) argue that Western countries have reservations about buying and deploying fully autonomous machinery. These challenges and hurdles are categorised into the following: (1) shortcomings, (2) potential to exacerbate conflicts, and (3) ethical considerations.

Firstly, while UGVs hold immense potential for reducing monetary costs and minimising human risks, autonomous systems have the potential to fall short in terms of intelligence and decision-making capabilities, rendering them unsuitable for certain missions. The light detection and ranging (LIDAR) sensors provide long-distance vision, in light and dark, to identify and avoid objects. However, this LIDAR technology can be detrimentally affected by poor weather conditions, dust, and dense flora, while the laser system emitting light waves is easily detectable by the relevant equipment (Gosselin-Malo, 2023). Additionally, despite the ongoing developments and advancements, machinery and technological systems can never be 100 per cent unerring. Thus, ground robotics of all sizes and functions require costly and timely oversight (Brown-Gaston & Arora, 2021).

Secondly, the precision and technological reliance on ground robotics in combat may lead to increased risks for human personnel. Military analysts like Donald Sando caution against over-reliance on technology, emphasising that it can intensify the complexities and brutality of warfare (Sando cited in Freedberg Jr., 2020). This aspect is interwoven with the ethical concerns of deploying ground robotics. However, this concern is more relevant to larger armed UGVs, as smaller reconnaissance UGVs offer greater standoff distances, thereby reducing potential harm to human life.

There are also worries arising from the creation of deepfake technology. Deepfakes relate to a simulation of reality generated with AI. In terms of warfare, such technology can disseminate false information and manipulate troops into following false orders (Weissman & Wooten, 2024). For example, hand-sized reconnaissance robotics sent into buildings to provide inspection and monitoring could be susceptible to deepfake technology. Similarly, the hacking of automated ground robotics could have harmful and detrimental impacts on human life. Thus, hesitancy stems from the potential for deepfakes to detrimentally impact military decision-making and alter outcomes.

Thirdly, there are important ethical considerations surrounding the deployment and utilisation of ground robotics. The absence of delineated and agreed-upon guidelines regarding accountability for war crimes carried out by (ground) robots poses significant challenges to its widespread proliferation. Joshi (2021) warns of potential violations of the principles of jus ad bellum, highlighting the risks associated with autonomous systems making unpredictable decisions. Therefore, human involvement in decision-making remains essential to ensure ethical conduct and the attribution of potential war crimes. Again, this is less likely to hinder the deployment of smaller UGVs, currently utilised predominantly for reconnaissance and mine-clearing.

Ground Robotics in Contemporary Combat Grounds

The proliferation of UGVs and ground robotics shaping modern combat is nowhere more evident than in the ongoing conflict between Russia and Ukraine. Remarkably, Ukraine has been declared the world's testing ground for military robots (Bendett, 2023; Burgess, 2024; Greene, 2022). The utilisation of ground robotics in Ukraine reflects a unique theatre of robotic engagement, influencing global attitudes toward autonomous weapons development (Greene, 2022). With both sides in the conflict demonstrating paralleled and constant engagements of ground robotics, global inhibitions towards developing autonomous weapons have been lowered (Greene, 2022). Consequently, the escalating use of ordnance is compelling other nations to develop machinery aimed at enhancing standoff distances between fighters, improving intelligence and surveillance, and reconnaissance capabilities (Rosenberg, 2023).

Ground robotics are currently deployed in various capacities, including logistics support, evacuation, and mine detection and destruction (Burgess, 2024). Ukrainian officials are overloaded with requests from robotics vendors seeking to test their systems for combat utility, underscoring the country's pivotal role as a testing ground for ground robotics (Gosselin-Malo, 2024). Notably, the Sirko-S1 UGV, developed by Ukraine's Brave1, is revolutionising battlefield operations. Tasked with transporting cargo, evacuating wounded soldiers, and conducting reconnaissance, the Sirko-S1 leverages drone technology to assist military personnel effectively (Malyasov, 2023). Feedback from frontline personnel is instrumental in refining such technology, leading to ongoing enhancements such as adding turrets and demining capabilities (Malyasov, 2023). This is both a sign that ground robotics are growing in importance for modern combat and that feedback from frontline personnel in Ukraine is instrumental in refining such technology.

Both the Russian and Ukrainian militaries are deploying aerial and ground robots at unprecedented rates, leading to a convergence of unmanned systems on the battlefield. The deployment of ground robotics conflict zones is presently unfolding concurrently with technological developments. This is providing an innovative stage for the unprecedented assay and development of ground robotics. Accordingly, expectations of further experimentation with autonomy, increased robot production, and the development of UGVs equipped with anti-drone technology are high (Bendett cited in Burgess, 2024).

To sum up, the ongoing war in Ukraine is indicative of continued developments in ground robotics and UGVs. Predictably, this trend in overcoming the challenges and hurdles would indeed foster a widespread proliferation of ground robotics. Although the trend towards adopting robotics in combat operations seems inevitable, its implications are yet to be seen as they remain dependent on ongoing developments.

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