HYBRID HUMANOID ROBOT

FROM HUMAN TO MACHINE: ACCOUNTABILITY IN AUTONOMOUS MILITARY SYSTEMS

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On my honor as a University student, I have neither given nor received unauthorized aid on this assignment as defined by the Honor Guidelines for Thesis-Related Assignments.

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General Research Problem

How does artificial intelligence reshape societal norms and existing power dynamics?

Artificial Intelligence (AI) has become a transformative force as it is starting to reshape industries and societal dynamics. As a result, the public is starting to discuss the broader implications of AI, focusing on issues like data privacy, algorithmic biases, and the potential erosion of individual autonomy. This research will take on a dual focus: firstly, examining the technical intricacies of crafting an autonomous humanoid robot designed for Navy vessel navigation. Secondly, delving into the legal considerations surrounding AI accountability in high-stakes contexts, particularly within the realm of warfare where life-and-death decisions are at stake. These two projects converge in their shared objective of unraveling the intricate web of AI's role in society. By navigating both the technical and legal landscapes, the research aims to provide a comprehensive understanding that bridges the gap between technological innovation and societal impacts. This paper mainly serves as a focused exploration of autonomy, not just as a technical endeavor but as a societal phenomenon with significant implications.

Hybrid Humanoid Robot

How can a compliant wheel/foot mechanism be designed for a humanoid robot to seamlessly traverse navy vessels and operate autonomously?

This project involves the overhauling of an existing humanoid robot which entails designing a state-of-the-art compliant wheel/foot mechanism. The wheels need to be able to deflate into the shape of a human foot to climb stairs and inflate back into wheels whenever the terrain it is traversing is clear. It will also feature an obstacle detection system as well as a self-balancing algorithm to allow it to move seamlessly and switch from wheels to feet without tipping over. Within the realm of robotics, humanoid robots have proven to be quite challenging to build and program to the point of full autonomy. Currently, the most successful designs have featured either a bipedal or a wheeled design for the robot's movement. Legged robots offer more flexibility over wheeled robots since they can mimic human movement and thus take on more human tasks including civilian and military activities, elderly assistance, etc. (Mikolajczyk et al., 2022). In comparison to wheeled robots, however, legged robots are often not stable and operate at lower speeds (Szeląg et al., 2023).

The robot will need to be able to calculate, in real-time, the speed it can travel based on the sensory data input as well as how much to raise or lower its legs to go up or down the stairs. Robot Operating System (ROS) will be integral to this project's success as it is a meta-operating system utilized in building robotics applications regardless of the hardware. ROS software is also organized as packages making it a valuable tool for modularity and reusability as it can be integrated and used for different robotic applications with very minimal changes (Bipin, 2018). It will be used to create the software packages that can analyze the data received from the robot's sensors and cameras and communicate with the motors to control the robot's precise movements since it has 23 degrees of freedom.

We will first start by experimenting with the wiring and software development of the motors on the legs of the humanoid and then use the knowledge gained from that step to program the whole robot system. Once the communication between the motors of one of the humanoids' parts is fully implemented and functional, the team will shift its focus to work on the program that will calculate the body's center of mass so it can balance itself and know when to reach for a handle or railing to avoid tripping or falling over. Prototypes of the complaint wheel/foot mechanism will be developed concurrently to have a working model to install onto the humanoid to perform the final rounds of testing. This is expected to be quite complex and will involve extensive testing as we implement the humanoid's autonomy. We will be doing our rigorous testing in a controlled environment that simulates the challenging conditions of Navy vessels. Our team will use specialized equipment and software for both the design and testing phases. Experiments will be conducted to evaluate the mechanism's responsiveness, robustness, and adaptability.

The significance of this project lies in the practical implications for sensitive applications like Navy vessels. Ensuring the robot's ability to navigate these diverse environments is not only a matter of operational efficiency but also of safety and effectiveness. The ability to transition between wheels and feet will reduce the need for human intervention and enhance the robot's autonomy, making it a valuable asset in complex and dynamic scenarios. As of now, humanoid robots equipped with compliant wheel/foot mechanisms are relatively scarce, and existing designs only feature either feet or wheels. As a result, they lack the required level of adaptability for high-stress, high-risk environments such as Navy vessels.

From Human to Machine: Accountability in Autonomous Military Systems

How do existing legal frameworks address autonomous military systems errors in situations where human lives are at risk?

In an era marked by rapid technological advancements, the integration of artificial intelligence into warfare raises critical questions that merit meticulous examination. The significance of this investigation lies in the potential ramifications of an evolving military landscape where increasingly autonomous AI systems are being granted life-and-death decision-making powers (Williams et al., 2021). This investigation seeks to comprehensively understand the legal frameworks governing AI in warfare. Thus, the key question emerges: Can AI be legally held accountable as an autonomous agent? Some claim that due to the lack of genuine goals and personal intentions, AI cannot be held responsible for its actions (Powers & Ganascia, 2020). This indicates that AI systems lack autonomy, as the philosophical definition of autonomy is an entity capable of defining its own rules of behavior on its own without the intervention of another entity (Elliott, 2018). The complexity lies in the fact that, in the eyes of the law, there needs to be an entity to hold accountable. As a result, this paper will focus strictly on the legal debates and frameworks surrounding responsibility in autonomous military systems and who or what is being held accountable. While there are significant ethical debates surrounding this issue, the scope of this study deliberately centers on the legal dimension. By doing so, I aim to provide a focused and thorough analysis of the specific legal challenges posed by autonomous military systems.

The integration of highly autonomous weapons into modern warfare has sparked profound concerns, particularly regarding legal implications when human lives are at stake. The 2003 invasion of Iraq serves as a poignant example, where the accidental shooting down of two friendly aircraft by the U.S. Army's Patriot air defense system resulted in the tragic loss of three allied service members (Scharre, 2018). This incident, stemming from a combination of a known technical flaw, outdated equipment, and human error, necessitates a thorough examination of accountability and responsibility within existing legal frameworks. Moreover, the disruptive potential of machine learning in military applications introduces additional complexities. Notably, MIT researchers successfully crafted a model turtle designed to deceive AI vision algorithms, leading to misidentification by AI systems (Knight, 2019). This highlights the vulnerability of autonomous systems to manipulations and the potential consequences of misidentification. In essence, the incident with the model turtle illustrates the real-world challenges of AI systems being deceived, emphasizing the need to address these vulnerabilities within legal frameworks.

These incidents, though unique, underscore the statistically inevitable nature of accidents in autonomous systems, prompting essential ethical and legal considerations in the deployment of autonomous military systems. As emphasized by Richard Danzig, a former U.S. secretary of the Navy, there is a historical tendency to underestimate the risk of accidents involving autonomous weapons within bureaucratic circles (Scharre, 2018). Recognizing and addressing these challenges – specifically, the potential for unintended consequences and misidentifications – within regulatory frameworks becomes increasingly critical as autonomous technologies advance. This would ensure that legal structures are adept at handling the intricacies of autonomous military systems, especially in situations involving potential harm to human life.

Actor-Network Theory (ANT) serves as a powerful lens for unpacking the intricate web of relations between human and non-human actors within the development, deployment, and consequences of AI technologies. ANT focuses on the relationships among various participants in a sociotechnical system illustrating how these interconnections impact both the participants and society at large (Latour, 1996). In the realm of autonomous military technology, a myriad of actors assume pivotal roles, collectively shaping the dynamic landscape. Military commanders are the authoritative figures wielding influence over the deployment of autonomous military technology. Simultaneously, AI developers exercise their influence through the design and programming of these technologies, effectively determining their decision-making capabilities. Policymakers occupy a crucial position by establishing the regulatory landscape that governs the use of automated systems in warfare, shaping the broader ethical and legal frameworks. Soldiers and operators on the ground, through direct interaction with autonomous systems, wield significant influence over their effectiveness. Their feedback and experiences contribute to the continuous adaptation and improvement of these technologies. This dynamic interaction among actors, spanning military commanders, AI developers, policymakers, and ground-level operators, creates a multifaceted network that significantly impacts autonomous military technology. ANT will help me unveil the complexities of these relationships, shedding light on the nuanced ways in which these actors influence and shape the sociotechnical landscape of AI in warfare.

The primary data source for this research involves an extensive policy analysis, concentrating specifically on relevant documents, reports, and legislative records related to the integration of AI in U.S. federal government military operations. To enrich the policy analysis, I plan to conduct expert interviews with individuals specializing in AI technology, military strategy, and international law. These interviews aim to provide insights into the practical implications of AI autonomy in warfare, offering perspectives not fully captured by policy documents alone. Key areas of exploration include decision-making processes in deploying autonomous military technology and the real-world challenges faced by those directly involved. These interviews will offer a qualitative analysis, providing firsthand perspectives and experiential knowledge. This will ultimately yield a richer understanding of the complex interplay between legal frameworks and the practical realities of deploying AI in military contexts.

Conclusion

The paper endeavors to investigate autonomy, with the technical portion focusing on how to integrate it with a humanoid robot to be used in Navy vessels and the STS portion focusing on the matter of autonomy accountability in military affairs. Through a rigorous approach encompassing interviews and document analysis, I aim to gain a comprehensive understanding of how the sociotechnical system shapes autonomous systems' accountability in warfare. Through the STS research, I aspire to unearth valuable insights into the intricate relationships among engineers, Navy personnel, regulatory bodies, and AI algorithms. Actor-Network Theory provides a lens through which I will analyze how these human and non-human actors interact and impact the accountability mechanisms within this sociotechnical system. Failure to grasp and address these legal issues can lead to severe consequences, including breaches of privacy, bias, and threats to safety. Furthermore, as AI becomes more integrated into our society, it is crucial to recognize the potential implications of accountability gaps for a wide range of stakeholders (Knuckey, 2016). This includes individuals who interact with AI systems in their daily lives and organizations that deploy these systems in high-stakes settings, such as the military. As the technical research progresses, the compliant wheel/foot mechanism as well as the control algorithm developed for the humanoid robot will serve as a tangible illustration of how technical advancements can enhance robots' performance in scenarios demanding agility and adaptability. The findings will not only fill knowledge gaps but also pave the way for future research and policy development in the field of AI governance. By addressing the complex sociotechnical dynamics shaping AI accountability and proposing technical solutions that align with these insights, I hope to foster responsible AI deployment in critical contexts.

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