**Thesis Project Portfolio**

**Hybrid Humanoid Robot (HHR)**

(Technical Report)

**Accountability in Warfare: Navigating the Legal Challenges of Lethal Autonomous Weapons Systems (LAWS) Deployment in Recent Conflict Zones**

(STS Research Paper)

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**Contents of Portfolio**

## Executive Summary

In the rapidly evolving field of military technology, the integration of autonomous systems presents both remarkable opportunities and significant ethical and legal challenges. This thesis portfolio delves into two projects: the development of a Hybrid Humanoid Robot (HHR) for U.S. Navy applications and a critical analysis of Lethal Autonomous Weapon Systems (LAWS) which examines the efficacy of current international law on regulating such systems in modern warfare. The HHR project explores innovative solutions to improve mobility and versatility in constrained naval environments, enhancing the robot's ability to perform critical tasks semi-autonomously while adhering to safety protocols. Concurrently, the STS research critically evaluates the expanding role of LAWS in global conflict zones, addressing the urgent need for updated legal frameworks that can effectively govern the use of autonomous technologies. New frameworks need to ensure compliance with international humanitarian laws and maintain ethical standards.

The technical portion of this portfolio introduces an innovative humanoid robot designed to significantly enhance operational efficiency on naval ships. This robot incorporates a dual-mode mobility system using a compliant foot/wheel mechanism, enabling seamless transitions between bipedal walking and wheeled movement. This functionality is crucial for maneuvering through the complex, obstacle-ridden environments typically aboard naval vessels, such as navigating tight passageways and overcoming physical barriers like ladders and watertight doors. The robot's design focuses on improving adaptability and stability, ensuring it can perform a variety of tasks ranging from routine inspections to emergency operations, all while minimizing human risk and increasing execution speed. Throughout the development process, the project team faced several challenges, including optimizing the balance between weight and stability and ensuring precise and smooth motion output from the 23 motors. This also included rigorous testing to ensure the robot could climb stairs and balance itself without any human intervention. Solutions included the use of lightweight, high-strength materials for the construction of the robot's frame and the integration of the control system using a controller with buttons mapped to each

limb consisting of 4-5 motors to ensure the smoothness of motion. Future enhancements are anticipated to integrate greater AI capabilities for improved decision-making processes and further automation of complex tasks.

The STS research portion aims to address the critical legal and ethical challenges associated with the increased deployment of LAWS. Legally, these systems test the boundaries of existing international humanitarian law, particularly the principles of distinction, proportionality, and accountability. The research explores how LAWS could potentially violate these principles without clear legal modifications and ethical guidelines. This involves a thorough review of current international treaties, academic literature, and case studies of recent conflicts where autonomous systems have been reported. Case studies include the accidental incidents in Iraq and the ongoing use of LAWS in conflict zones like Ukraine and Gaza. These incidents serve to highlight the inadequacies of current international laws in mitigating civilian casualties and ensuring accountability among the complex network of actors involved. From the analysis, it is clear that new legal instruments and amendments to existing treaties are required to specifically address the use of autonomous systems in warfare. The recommendations include establishing clear criteria for the development, testing, and deployment of LAWS to ensure they comply with international humanitarian law. Additionally, the study advocates for maintaining meaningful human control over critical combat functions to prevent unintended escalations and preserve ethical accountability. By providing a detailed analysis of the ethical and legal intricacies surrounding LAWS, the research aims to inform future legislation and promote a more humane approach to the use of technology in warfare.

Integrating the findings from both the technical and STS research, this portfolio not only illustrates the cutting-edge developments in military robotics but also the imperative for concurrent evolution in the legal and ethical frameworks that govern their use. The advancements demonstrated by the HHR project in enhancing robotic performance and safety in complex naval environments are paralleled by the need for robust legal strategies, as explored in the STS project, to regulate and guide the

ethical deployment of autonomous systems like LAWS. The combined insights from these projects emphasize the necessity for a holistic approach to military technology innovation—one that harmonizes the capabilities of autonomous systems with stringent ethical and legal standards to ensure their beneficial integration into military practice. There definitely should be an ongoing dialogue and research effort aimed at understanding and integrating advanced technologies within a strong ethical and legal framework. For LAWS, this might involve international treaties that explicitly address autonomy in weapon systems, ensuring they adhere to established humanitarian principles. For humanoid robots like the HHR, further research could explore their use in civilian contexts, expanding their benefit beyond military applications.