Deliverable C: Design Criteria

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Introduction

The development of ethical and responsible robotics has become a crucial area of focus in engineering design, specifically in the context of autonomous robots. This project aims to repurpose the RoboMaster S1 from a combat training tool into a peaceful and educational platform, emphasizing ethical concerns surrounding autonomous robots and weapons. Through a structured design process, functional requirements and non-functional requirements, as well as constraints, have been identified to guide this repurposing. Benchmarking against similar robotic platforms such as SPOT, Misty II, and Husky A300 has provided insights into performance metrics, ensuring that the modified RoboMaster S1 aligns with ethical concerns while maintaining its technical capabilities. The project also incorporates user needs, target specifications, and feedback from the client meetings to refine the design criteria, ensuring that the final product effectively conveys an anti-warfare message while maintaining accessibility, engagement, and technical feasibility.

Design criteria

To effectively transform the RoboMaster S1 into a peaceful and educational tool, a comprehensive set of design criteria has been established. These criteria are comprised of functional and non-functional requirements, as well as key constraints, ensuring that the modified robot aligns with ethical considerations while maintaining optimal performance.

Green - Functional Requirements

Blue – Non-Functional Requirements

Red - Constraints

Criteria	Rank
Transform the Robomaster S1 into a peaceful tool	5
Demonstrate 3 ethical concerns related to autonomous weapons	5
Promote responsible robotics	5
Use creative expression to enhance user engagement	2
Ensure message will not cause offence	2
Emotional impact on viewers	2
Must be under 90 seconds	5
Must not target specific individuals	4
Avoid glorifying autonomous weapons	4
Must have no permanent physical changes done to the robot	4
No cost	3

Benchmarking

The consideration of products like ours, especially ethically, comes down to who else has decided to take charge of the autonomous weapons issue. This is a global movement with many parties involved. Therefore, determining products for technical benchmarking will be based on how robots are used in anti-war actions. So, the products being compared do not need to be killer robots but are instead how different robots used for peaceful acts, perform against the RoboMaster S1. The key things that will be evaluated are speed, range perception, camera resolution, battery life, the weight capacity that can be held by each robot, and finally the overall durability in different temperatures and conditions. There are three products that will be compared in addition to the RoboMaster S1. Those products are SPOT; a robot used for search and rescue, Misty II; a robot used for education and research purposes, and finally the Husky A300; a robot used in robotics research in outdoor environments.

Table 2: Technical benchmarking for the product.

	Importance Weighing	RoboMaster S1	SPOT	Misty II	Husky A300
Company		DJI	Boston Dynamics	Misty Robotics	Clearpath
Speed	2	Top speeds of 12.6km/h	Top speeds of 5.7km/h	Top speed of 1.62km/h	Top speed of 7.2km/h
Range perception	3	Varies between 3m-6m depending on lighting	Up to 4m	Up to 1.2 meters	Up to 35 meters
Camera Resolution	2	2560x1440 at 30fps	640x512 at 7.5hz when opting into the Cam+IR kit	4208x3120 at 35fps	1200p at 60fps when opting into the vision package
Battery Life	3	Minimum 60 minutes	Has an average run time 90min	Up to 10 hours when idle and 2.2 hours when running	Extended run time of 12 hours
Payload capacity	2	Has a tested payload of 6.6lb	30.9lb	33lb	220lb
Temperature limits	1	-10℃ to 40℃	-22℃ to 55℃	5℃ to 40℃	-20℃ to 40℃

When comparing the specifications form the technical benchmarking above, the Husky A300 has the best specifications in terms of overall ability to be used for diverse types of anti-war methods.

The following section contains three users as well as how they may use the product, in comparison to how the RoboMaster can be used for this same task. The products will be the same as the ones in the technical benchmarking.

Similar User	Needs	Products used	How the RoboMaster S1 can be used in this
Emergency crews	To investigate areas especially in search and rescues	Spot	The RoboMaster S1 can be used for indoor search and rescue and can especially thrive in smaller rooms. This makes the RoboMaster ideal for smoky houses and aid in searching of trapped civilians.
Students of all ages	To learn robotics and coding in a fun and engaging way.	Misty II	The RoboMaster offers simple scratch code and python to facilitate the learning experience on a powerful platform. The RoboMaster can also be a cheaper alternative for students to learn.
Agricultural Researchers	To monitor crops, analyzeplant health and keep track of all plants in a greenhouse	Husky A300	The RoboMaster S1 can offers amazing sensors and great resolution to track a plants health as well as keep track of the crops within a green house. It's 360 degrees of rotation also allows it to see all plants and ensure nothing is missed.

As seen above, there are many available users that can benefit from the repurposing and utilization of the RoboMaster S1 in anti-war ways. There are many more users than the ones listed that can benefit from the RoboMaster S1.

Target specifications

PERFORMANCE AND FUNCTIONALITY

SPECIFICATION	**TARGET VALUE**	**RATIONALE**
RANGE PERCEPTION	3-6 meters	Good obstacle detection while balancing cost
CAMERA RESOLUTION	Minimum 2560x1440 at 30fps	Good quality image capture for educational message
BATTERY LIFE	Minimum 60 minutes	Good operational time without frequent recharging
PAYLOAD CAPACITY	At least 6.6 lbs (3kg)	Stability if carrying additional attachments
TEMPERATURE TOLERANCE	-10C to 40C	Suitable for indoor or outdoor use.
SPEED	5-10km/h	Good, controlled movement while having some flexibility in its performance.

ETHICAL AND DESIGN CONSTRAINTS

SPECIFICATION	TARGET VALUE	RATIONALE
VIDEO LENGTH	Max 90 seconds	Keeps message concise and engaging while meeting project requirements
ETHICS	Demonstrate 3 ethical concerns	Alings with project requirements
MODIFICATION LIMITS	No permanent damage to the robot	Preserves reusability and compliance with constraints
MESSAGE GUIDELINES	Don't target certain individuals or glorify autonomous weapons	Ensures responsible communication and ethical message
COST	No additional cost beyond existing resources	Maintains accessibility and feasibility within project scope.

The target specifications for the modified RoboMaster S1 ensure that the robot meets the ethical and performance requirements while staying within the constraints of the project. These specifications were derived from technical benchmarking, design criteria, and client feedback

The performance-related targets are based on comparisons with similar robots, ensuring that the RoboMaster S1 remains effective for its non-combat role. The ethical constraints ensure that the messaging aligns with anti-war principes avoiding the glorification of autonomous weapons.

Overall, the target specifications provide a reference for evaluating the solutions while keeping aligned with the project's goals.

Reflection on client meeting

The client meeting helped us refine our design criteria in terms of priorities and convergence with the vision of the product. There were also ethical considerations raised, including avoidance of glorification for autonomous weaponry and respect in messaging. This, therefore, provided for higher-order functional requirements and constraints regarding ethical concerns.

Similarly, there were educational objective, but these were mainly to increase awareness I audiences about the algorithmic biases and human judgement, particularly for policy makers and industry leaders. Creative elements were less paramount and only to ensure engagement did not compromise the integrity of the message.

Moreover, it has been emphasized that the meeting underlined that the demonstrations with the Robomaster S1 must clearly challenge the ideology of training students for programming autonomous weapons, meaning that the project must sustainably subvert its foreseen use while illustrating at least 3 ethical concerns.

Also, political neutrality and accessibility were underlined to make sure that the project sends a strong anti-war message without accusing individuals, groups, or states. Finally public engagement and impact-presupposing that the demo is to be not only something to consider but also easily understandable and sharable.

Conclusion

The transformation of the RoboMaster S1 into a peaceful and educational tool underlines the importance of ethical concerns in robotics and autonomous systems. Through comprehensive design criteria, technical benchmarking, and target specifications, the project ensures that the repurposed robot aligns with responsible robotics principles, while maintaining its functional capabilities. The insights gained from benchmarking comparable robots, as well as the feedback from client meetings, have helped refine the design to effectively communicate an anti-war message without compromising technical performance or accessibility. By addressing ethical concerns, ensuring inclusivity, and emphasizing responsible innovation, this project serves as a demonstration of how robotics can be harnessed for constructive and educational purposes instead of being used for warfare, contributing to a broader use for the autonomous systems in the future.

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