A11 - Ethical and Environmental Analysis

Year: 2024 Semester: Fall Team: 5 Project: Dodgebot

Creation Date: April 5, 2024 Last Modified: April 5, 2024

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Assignment Evaluation: See the Rubric in the Brightspace Assignment

1. Environmental Impact Analysis

The manufacturing and end-of-life processes of the Robot Punch Dodging System may pose environmental concerns. While the components used are common in consumer electronics, certain manufacturing processes, such as PCB fabrication, involve potentially harmful chemicals. Additionally, the system's reliance on rare earth metals and non-biodegradable materials could contribute to environmental degradation during disposal. Diving deeper into the details:

# Manufacture

1. Chemical Usage:  
   The manufacture of the Robot Punch Dodging System involves processes like PCB fabrication, which utilize hazardous chemicals. These chemicals pose risks to both human health and the environment due to their toxicity and potential for environmental contamination.
2. Material Selection:  
   Rare earth metals and non-biodegradable materials are commonly used in electronic components, contributing to resource depletion, and increasing landfill waste.

# Normal Use

1. Energy Consumption:  
   The system requires electricity, contributing to energy consumption and emissions.
2. Longevity:  
   Short product lifespans can lead to increased electronic waste, as outdated or malfunctioning systems are disposed of prematurely.

# Disposal/Recycling:

1. Electronic Waste:  
   Upon disposal, electronic components may release hazardous substances into the environment if not properly recycled or disposed of. Non-biodegradable materials contribute to landfill accumulation.
2. Rare Earth Metal Depletion:  
   Disposal of electronic devices contributes to the depletion of rare earth metals, which are essential but limited in supply.

What is our team doing to address these Environmental Impact Concerns? Below are the specific considerations for each topic we have implemented to our process.

Manufacture

1. Chemical Management:  
   By selecting reputable manufacturersto provide the core parts of DodgeBot:  
   Motors - Yaskawa  
   Microcontroller – STM32[1][2]  
   We ensure that we can minimize the environmental impact in the early stages of the product manufacturing process. As you can read in the references above, the carbon footprint of an “Ultra-Low-Power” microcontroller unit and effective chemical waste management tactics make this a suitable option for managing our impact on pollution. The Yaskawa motors were also picked at a premium over other options, but the construction of the motors is much more solid which gives us leeway in case of malfunction from spilling any potentially hazardous substances.
2. Material Selection:  
   We are also adhering to best practices when manufacturing the custom parts this project requires with the guidance of Purdue staff. This includes the mechanical casing for the motors made from aluminum and steel. The best part of these materials is that beside from being 100% reusable, at the amounts that we are using[3], the carbon footprint is very small. Given that the product is over 9000$ in materials cost alone, the carbon footprint impact per dollar cost of the final product will be minimized here.

# Normal Use

1. Energy Efficiency:  
   Design the system for optimal energy efficiency, utilizing power-saving features and components to minimize energy consumption during normal use. By design, we will only be exerting the lease necessary power from the motors to move to the desired location, and we do not have any unnecessary features or animations besides safety protocols.
2. Longevity:  
   Here, again we must come to mention the benefit of going with high-end motors. The durability of these machines will reduce the impact on the environment by reducing disposal. Furthermore, by using a general purposemicro controller and python based coed, it would be very easy to provide firmware updates and maintenance support to extend the useful life of the system.

Disposal/Recycling

1. Recycling Programs:  
   Implement a comprehensive recycling program for electronic waste, allowing users to return outdated or non-functional systems for proper recycling and disposal of hazardous materials.
2. Material Recovery:  
   Explore methods for recovering and reusing rare earth metals from discarded electronic components, reducing reliance on finite resources, and minimizing environmental impact.

By addressing environmental concerns at each stage of the product life cycle, including manufacture, normal use, and disposal/recycling, the Robot Punch Dodging System can minimize its environmental footprint and promote sustainability in electronic design and production. Through careful material selection, efficient manufacturing processes, and responsible end-of-life management, the system can mitigate environmental risks and contribute to a more sustainable future.

1. Ethical Challenges

The project raises ethical considerations regarding user safety and privacy when bringing the design to the market. Misuse of the system, such as attempting to interact with it while in motion, could lead to accidents or injuries. Proper warnings and precautions must be implemented to mitigate these risks. Additionally, the potential for electrical failures or data corruption emphasizes the need for clear user documentation and warnings. Lastly, avoiding misleading or deceptive advertising practices that could misrepresent the capabilities or limitations of the system will be key for the project to adhere to fair marketing practices. We have addressed these ethical challenges here:

# User Safety:

1. Testing and Validation:  
   Our codebase is meticulously organized into classes, each serving a distinct purpose, to ensure clear separation of concerns and facilitate modular development. By aligning dependencies carefully, we isolate components for streamlined testing at every stage of the development cycle. Leveraging dependency injection enhances testability and flexibility by decoupling dependencies from the classes they serve, enabling deterministic and reproducible testing. Furthermore, we employ GitHub Actions for automated testing, integrating continuous integration and deployment pipelines into our workflow to provide transparent and reliable test results publicly. This approach not only ensures the stability and reliability of our firmware but also fosters accountability and transparency within our development process.
2. Warning Labels:  
   Clearly label the system with warnings about potential risks and proper usage guidelines. Especially when it comes to the key areas of the circuit connection, given the high levels of power flowing through the motors. This includes placement of warning labels on the device itself and in user documentation.
3. User Education:  
   Provide comprehensive user documentation that includes clear instructions on safe usage practices and potential risks associated with improper use. This can include guidelines for mounting the device securely and avoiding interaction while in motion. More importantly, it would be useful to implement a responsive questionnaire before the user can turn on the program. Users should be able to expect the behaviors of DodgeBot and be prepared as it operates.

# Privacy Concerns:

1. Data Security Measures:  
   There is absolutely no data collected by the user that is shared over any sort of connection to any other parties and data collection is in no way a goal of this product.

Fair Marketing Practices:

1. Truthful Representation:  
   Ensure that all marketing materials accurately represent the capabilities and limitations of the system. Avoid exaggerating performance or making unsubstantiated claims, especially to professional boxers, for whom this product might not be the best.

By addressing ethical challenges such as user safety, privacy concerns, and fair marketing practices, the team can ensure that the design and marketing of the Robot Punch Dodging System are conducted in an ethical and responsible manner. Through testing, transparent communication, and adherence to ethical principles, the team can build trust with users and potential stakeholders while promoting the ethical use of technology.

3.0 Sources Cited

[1] STMicroelectronics. (n.d.). Footprint of an Ultra-Low-Power MCU. [Online]. Available: <https://www.st.com/content/st_com/en/about/st_approach_to_sustainability/sustainability-priorities/sustainable-technology/eco-design/footprint-of-an-ultra-low-power-mcu.html>

[2] STMicroelectronics. (n.d.). Waste Management. [Online]. Available: <https://sustainabilityreports.st.com/sr22/environment/waste.html>

[3] 8 Billion Trees. (n.d.). Carbon Footprint of Steel. [Online]. Available: <https://8billiontrees.com/carbon-offsets-credits/carbon-footprint-of-steel/#:~:text=The%20emissions%20factor%20when%20calculating,1kg%20%3D%206.15CO2eq>