Robots Without Borders

Water Purification Buggy

Problem Statement

The problem faced by communities in areas like Chad and Kenya is immense: individuals often endure treks of up to 30 miles to reach water sources that are not only distant but frequently contaminated. These long journeys contribute to severe physical atrophy over time, as villagers, including women and children, carry up to 40 pounds of water daily. This repeated strain can lead to musculoskeletal issues and chronic pain. Additionally, the use of contaminated water exposes these communities to dangerous diseases such as cholera, dysentery, and typhoid, which contribute to high morbidity rates and further destabilize their social and economic fabric. The water filtration buggy provides a transformative solution by reducing the physical burden and supplying safe, drinkable water, directly supporting community health and resilience. Our mission aligns with Robots Without Borders' core objective of equipping communities with the skills and resources to build life-improving technologies. To this end, we have begun shipping parts to regions such as Kenya and Tibet, empowering local communities to assemble and deploy this essential tool. The solar-powered water filtration buggy is a groundbreaking innovation that has the potential to save countless lives in underprivileged communities by providing reliable access to clean water.

Mechanical Design

The mechanical design of the buggy emphasizes both mobility and structural integrity, allowing villagers to transport up to 80 pounds of water with ease. The chassis is constructed from reinforced, corrosion-resistant steel that maintains a low center of gravity, preventing tipping even on uneven terrain. Large, durable wheels with deep, rugged treads provide superior traction on surfaces ranging from rocky paths to muddy trails, ensuring smooth and reliable movement. The wheel axles are reinforced with high-strength alloys to bear significant loads without deforming, enhancing the overall

durability of the buggy. An ergonomic handle, adjustable in height, facilitates optimal user leverage, minimizing physical strain and improving the pulling or pushing experience. The entire structure underwent extensive stress testing, simulating repeated use in harsh conditions to guarantee the design's long-term reliability and dependability. These engineering measures ensure that the buggy remains functional and robust under continuous daily use.

Water Purification Flow Dynamics

The water filtration system within the buggy incorporates a multi-stage purification process designed for maximum efficacy. Water first enters the raw water container, where it is pre-filtered through a high-capacity sediment and carbon filter. This initial stage effectively removes suspended particles, sediments, and organic contaminants. The filtered water then passes through a flexible, reinforced silicone tube, sealed with specialized leak-proof tape to prevent leaks or contamination. The water is drawn through the system by a solar-powered pump capable of operating at a flow rate of 20 gallons per hour. This pump is designed with a brushless motor to maximize efficiency and minimize wear, ensuring sustained operation. The water then enters the UV sterilization chamber, which uses a 254 nm wavelength to deactivate bacteria, viruses, and protozoa, including resilient pathogens such as giardia and E. coli. The UV lamp is shielded with a quartz sleeve for protection, ensuring optimal light transmission and prolonged life. Finally, the pump pushes the sterilized water into a sealed filtered container. A user-friendly release valve with a reinforced seal allows villagers to dispense the clean water as needed, minimizing contact and ensuring the water's purity.

Electrical Components

Ensuring efficient energy management required meticulous attention to the electrical components of the buggy. The solar panel is connected to a charge controller that regulates the flow of electricity to a rechargeable lithium-ion battery. This setup ensures that excess power generated during peak sunlight hours is stored for later use, allowing the filtration system to operate even in low-light conditions. The electrical connections were meticulously crafted, with the positive and negative terminals connected using

high-conductivity copper wires and insulated crimp connectors to maintain a stable circuit. Voltage regulators and step-up converters were employed to optimize power delivery to the pump and UV sterilizer, preventing energy drops that could disrupt the filtration process. Each electrical component was housed in a waterproof, impact-resistant casing to prevent damage from environmental exposure. This attention to electrical insulation and grounding techniques reinforced the reliability of the system, ensuring consistent, safe operation even under variable conditions.

Engineering Design Process

Bringing the water filtration buggy to life was an iterative journey, rooted in thorough research and continuous improvement. The initial proof of concept was constructed using LEGO blocks and FTC metal parts to test core mobility and filtration mechanisms. This phase revealed key insights into load distribution and mechanical stability, guiding enhancements for the prototype stage. The next prototype incorporated basic filtration units and solar panels, allowing us to test energy efficiency and filtration capacity in real-world conditions. The final model evolved into a robust solution using high-grade metal containers and advanced multi-stage filters. Collaborations with water quality organizations like WaterAid and Lifewater International provided essential feedback on purification standards, while consultations with hydrologists and solar technology experts helped refine the system’s effectiveness. We adhered to engineering principles of reliability, quality, and dependability through rigorous field testing, repeated trials, and component optimization. This commitment, combined with expert input and community feedback, ensured that the water filtration buggy is a dependable, impactful solution for communities in need.