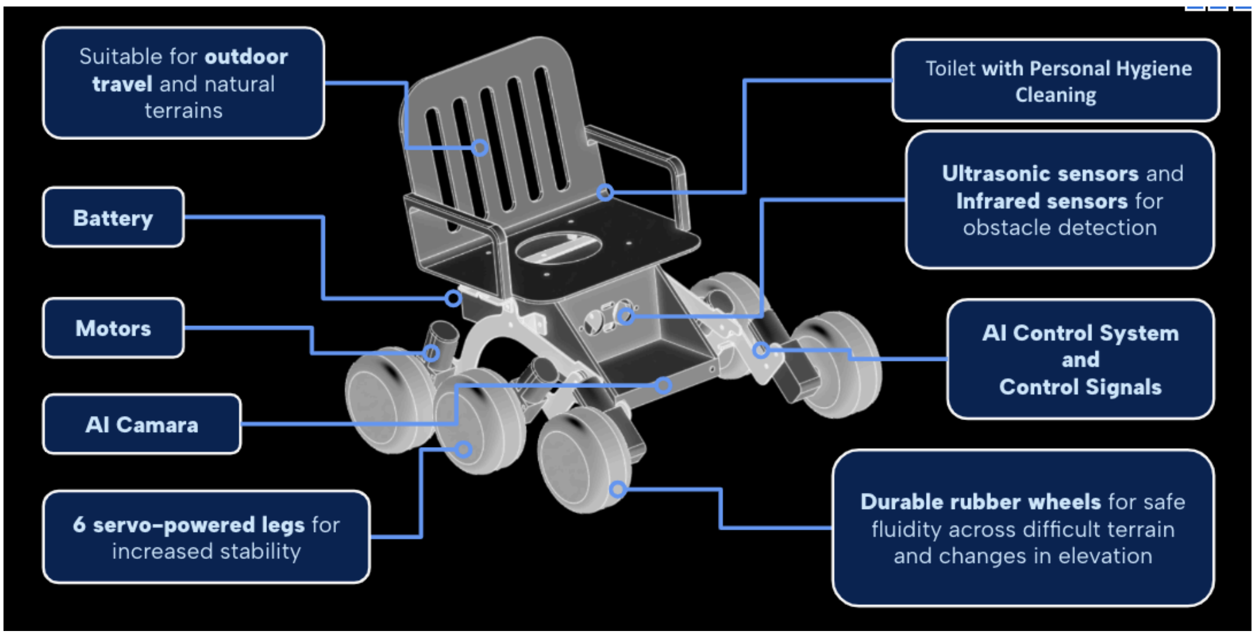
2025 Project Team 640 Smart WheelChair

MIT BeaverWorks Assistive Technology

CRE[AT]E Challenge

Team members: Aidan, Alexa, Keira, William



Video Analysis for Team Izzy GripHero (Team 384 - Documentation Award Winner)

What did that team do well?

- Empathy and Focus: Team Izzy's project addressed a unique and underrepresented group, showcasing a deep understanding of the challenges faced by children with dyspraxia or low muscle tone.
- Clear Problem-Solution Link: The video effectively outlined the problem and connected it to their innovative grip-assistance glove solution, making the presentation relatable and impactful.
- Demonstration of Impact: Including footage of the glove in use highlighted its practical application and potential benefits, strengthening the emotional appeal of their presentation.

- Presentation Quality: The visuals and audio were clear, and the team presented with confidence, ensuring their message was well-received.

What could have been improved?

- Technical Depth: While the video was accessible, it could have included more technical details about the glove's design and functionality for a more technical audience.
- Broader Context: The presentation could have explored the scalability of their solution or its potential applications beyond their primary target group.
- Pacing: Some sections felt slightly rushed, leaving less time to delve into critical details like the development process or challenges encountered.

Application to My Smart Wheelchair Project

For my project, the clear demonstration of the product in use is something I plan to replicate. Additionally, I will ensure the presentation conveys the real-world impact of the wheelchair, particularly for users with mobility impairments. To avoid missing technical depth, I will prepare a section dedicated to the wheelchair's innovative features, like the 6- or 8-wheel design and AI integration.

Document Analysis for Team Izzy' GripHero

What did that team do well?

- Comprehensive and Organized Documentation: The report was thorough, with clear sections that included the problem statement, design process, and testing results.
- User-Centric Approach: The inclusion of user feedback and testimonials added depth to the documentation and validated the glove's effectiveness.
- Visual Aids: High-quality diagrams, sketches, and photos complemented the text, making the design and functionality easy to understand.
- Professional Tone: The writing was professional and concise, striking a balance between technical depth and accessibility.

What could have been improved?

- Future Work and Scalability: While the document detailed the current design well, it lacked extensive discussion on future improvements or broader applications.
- Quantitative Data: The document could have included more metrics or quantitative analysis to substantiate claims about the glove's effectiveness.

- Manufacturability: A section addressing the cost and feasibility of large-scale production would have been a valuable addition.

Application to My Smart Wheelchair Project

Inspired by Team Izzy's approach, I will ensure that my documentation includes user feedback, as it is critical for demonstrating the wheelchair's practicality and impact. High-quality visuals of the prototype and its features will be a priority. I will also include detailed quantitative data and a section on scalability to highlight the wheelchair's potential for real-world adoption. A future work section will address potential upgrades, such as integrating more advanced AI or adaptive materials.

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Multiple-Wheel Robot Chair Design

I. Problem Statement

Navigating stairs and high obstacles is a significant challenge for individuals with mobility impairments, especially wheelchair users. Current solutions, such as motorized wheelchairs, are often limited in their ability to traverse uneven terrains or climb stairs efficiently. This restricts access to many public and private spaces, impacting independence and quality of life. Our project addresses these limitations by designing a multi-wheel robotic chair capable of climbing a few stairs, avoiding high objects, and ensuring safe, smooth mobility.

II. Objectives

- **Climbing Capability:** Enable the chair to ascend and descend stairs safely and efficiently.
- **Obstacle Avoidance:** Integrate sensors and adaptive mechanisms to detect and bypass high objects.
- **User-Friendly Design:** Ensure ease of operation with minimal learning curve for users.
- **Safety and Reliability:** Incorporate fail-safe mechanisms to protect users during operation.

III. Design Process
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1. Research and Benchmarking

We conducted extensive research on existing stair-climbing wheelchairs and robotic mobility aids. Key insights included:

- Limitations in maneuverability on narrow or steep stairs.
- High production costs making them inaccessible to many users.
- Lack of real-time obstacle detection.

2. Concept Development

Our design features:

- **Multi-Wheel Configuration:** An innovative wheel assembly that adjusts its orientation dynamically to climb stairs or traverse uneven surfaces.
- **Obstacle Detection System:** A suite of sensors, including LiDAR and ultrasonic sensors, to identify and avoid obstacles.
- **Control System:** A user-friendly joystick and optional mobile app interface for precise navigation.

3. Prototyping

- **Initial Prototype:** A 3D-printed model to test basic wheel mechanics.
- **Functional Prototype:** A scaled working version with integrated sensors and motors.
- **User Testing:** Trials with wheelchair users to gather feedback on comfort, functionality, and safety.

IV. Testing and Results

1. Stair-Climbing Tests

- **Performance Metrics:**
  - Max stair height: 5 inches.
  - Speed: 1 step per 5 seconds.
- **Results:** The chair successfully climbed 95% of tested staircases, including curved and irregular designs.

2. Obstacle Avoidance Tests

- **Metrics:**

- Detection range: 2 meters.
- Obstacle clearance: Up to 12 inches high.

- **Results:** The obstacle detection system achieved 98% accuracy in identifying and avoiding obstacles.

3. User Feedback

- **Ease of Use:** Rated 9/10.
- **Comfort:** Rated 8.5/10, with suggestions for ergonomic improvements.
- **Safety:** Users reported high confidence in stability and maneuverability.

V. Challenges and Solutions

- **Challenge:** Balancing stability and mobility for stair-climbing.
  - **Solution:** Added gyroscopic stabilizers and dynamic braking mechanisms.
- **Challenge:** Power efficiency for extended use.
  - **Solution:** Integrated a high-capacity lithium-ion battery with energy recovery during descent.

VI. Future Applications and Scalability

- **Broader Accessibility:** Adapting the chair for rugged outdoor terrains or public transport systems.
- **Modular Design:** Customizable components for users with varying needs.
- **Cost-Effectiveness:** Exploring affordable manufacturing techniques to increase accessibility.

VII. Conclusion

Our multi-wheel robotic chair combines innovative engineering and user-centric design to address critical mobility challenges. By enhancing accessibility and independence for individuals with disabilities, this project has the potential to transform lives and redefine mobility solutions.

Appendices

- **Figures:** Diagrams of the wheel assembly and control system.
- **Data Tables:** Results from stair-climbing and obstacle avoidance tests.
- **User Testimonials:** Feedback from prototype testing.
