2025 Project Team 640 Smart WheelChair MIT BeaverWorks Assistive Technology CRE[AT]E Challenge

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User Needs and Product Requirements: Once you have found a co-designer and had a chance to conduct an interview, let's think back to the Design Process section.

What are some of the sub-problems that your product must solve? Draw a functional diagram of the product, and tell us what the inputs and outputs of the functional diagram are. As a reminder, inputs and outputs are typically energy, material, control, or signals associated with your product.

Assignment: Needs and Requirements

Write down a set of user needs statements that you have extracted from the interview. They may be related to the same activity or disability-related challenge, or they may not be. You might try grouping the user needs if you find clusters that are related. For each user's need, write one or more product requirements that are associated with that need. Remember that your eventual project does not need to address every challenge expressed during the interview. This step is just to get you ready for product brainstorming.

Design Process Section

**Sub-Problems and Functional Diagram**

Sub-Problems to Solve:

1. **Mobility on challenging terrains:** Enable navigation over stairs, slopes, and uneven surfaces with minimal user input.
2. **Restroom accessibility outdoors:** Provide an integrated solution for restroom needs to avoid limitations in outings.
3. **User independence and convenience:** Reduce reliance on external assistance by incorporating user-friendly features like storage compartments, self-cleaning toilet systems, and reminders.

4. **Obstacle avoidance and safety:** Ensure the wheelchair avoids collisions and finds the safest paths automatically.
5. **User comfort and social interaction:** Include features to enhance comfort (like fans) and ensure compatibility with social and outdoor environments.

Functional Diagram:

Here is the functional diagram of a 6-wheel smart wheelchair. It illustrates the key components such as motors, sensors, AI processing units, and user interfaces, along with the inputs and outputs of the system:
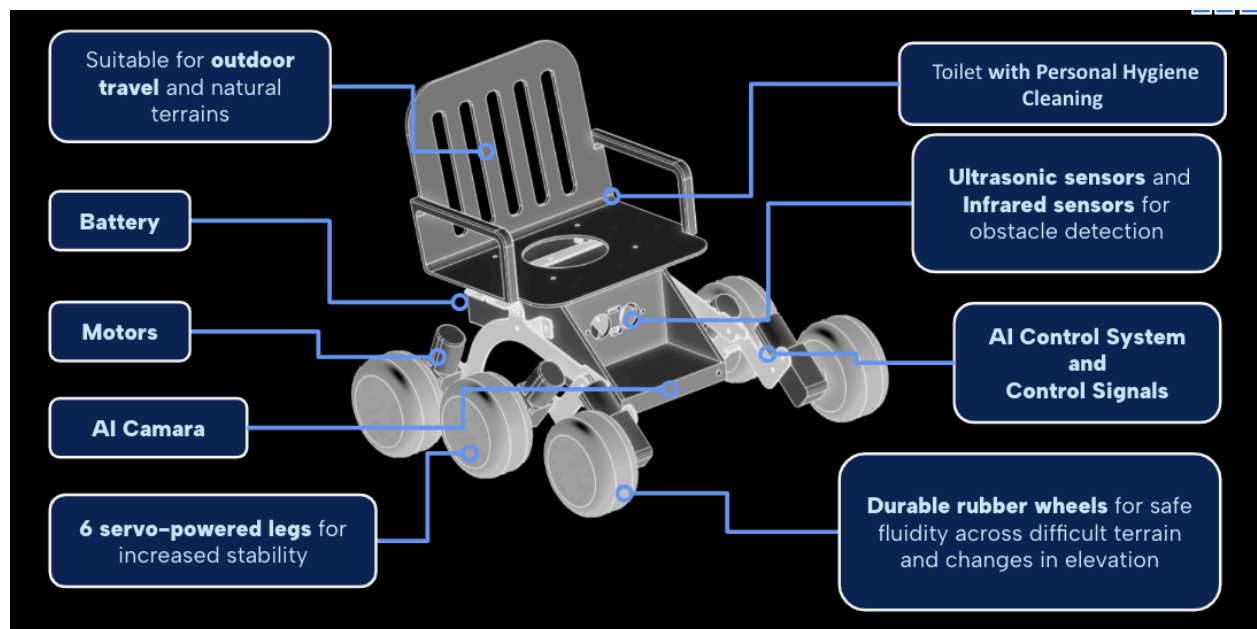
Inputs:

- **Energy:** Battery power for motors and sensors.
- **Material:** Lightweight yet durable materials for the wheelchair frame.
- **Control Signals:** Commands from the user interface or autonomous control system.
- **Sensor Data:** Inputs from ultrasonic sensors, infrared sensors, and AI cameras.

Outputs:

- **Mobility Actions:** Wheelchair movement, stair climbing, and slope navigation.
- **User Alerts:** Notifications for obstacles or maintenance needs.
- **Convenience Functions:** Activation of storage, restroom systems, or climate control.
- **Data Feedback:** Real-time status updates for the user.

Needs and Requirements

User Needs Statements:

1. Navigate safely over uneven terrain and small stairs.
2. Access restroom facilities during outdoor trips without hassle.
3. Maintain autonomy in daily activities with minimal external help.
4. Enjoy nature and social interactions comfortably.
5. Feel safe and supported in the chair during operation.

Product Requirements:

1. Integrate a multi-wheel design capable of climbing obstacles up to a wheel's height.
2. Employ AI-based obstacle avoidance and pathfinding with sensor fusion.
3. Ensure an ergonomic design for prolonged comfort and adaptability.
4. Offer ample storage and user-friendly features like a cooling fan.
5. Operate with a long-lasting battery and energy-efficient systems.
6. Include a self-contained, self-cleaning restroom system with a waste disposal bag.

The above approach focuses on creating a functional, intuitive, and user-centered smart wheelchair that addresses both physical and emotional challenges while promoting independence and quality of life.