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Wearable Wonders: The Latest Advancements in Exoskeleton Technology

Exoskeletons, wearable robotic devices that provide powered assistance and mobility support, possess transformative potential for those with physical disabilities. Although the first exoskeleton system was cleared by the FDA for public use in 2014 (ReWalk Personal System), recent years have seen rapid advancements in this technology. From longer-lasting battery systems and intuitive control interfaces to customizable, modular designs, researchers are advancing exoskeleton capabilities into new realms. This article explores the innovative developments enhancing comfort, independence, and rehabilitation for exoskeleton users worldwide.

A major focus area driving recent exoskeleton advancements has been extending battery life while reducing overall system weight. This allows for increased mobility and comfort for the user, as it reduces wearing time fatigue. As an example, researchers at the University of Waterloo made strides on this front with their KeOx exoskeleton, integrating a new lithium-ion battery pack that increased operating time by 25%, compared to previous iterations. In addition, The Chinese Academies of Science's Mind Robotics exoskeleton incorporated advanced lithium polymer cells, enabling over 6 hours of continuous use while keeping the battery backpack under 5 lbs.

At the same time, power consumption can be optimized by dynamically adjusting motor outputs based on the user's movements and environment. For instance, ETH Zurich's Momentum exoskeleton utilizes model-predictive control informed by onboard sensors. These sensors can anticipate the user's intended trajectory and apply precise torque assistance, significantly boosting battery efficiency. By leveraging these onboard sensors for gait tracking, terrain sensing, and user intent recognition, modern exoskeletons can intelligently modulate their power output, minimize wasted energy, and optimize battery efficiency.

One of the most fascinating recent developments is with Wandercraft's Personal Exoskeleton, which is powered by hybrid robotic technology. It is the first, and only, self-stabilizing exoskeleton on the market for everyday use that allows persons with physical impairments to walk hands-free (without devices) throughout their communities. It was designed to operate in unpredictable urban environments, allowing wearers to control their direction, cross steps or sidewalks, and maintain their balance despite disturbances or pushes.

The therapeutic applications of exoskeletons are immense, helping their users regain strength and mobility following prolonged periods of immobility. Significant recent research, including in peer-reviewed journals, has shown that robotic exoskeleton training can induce neural plasticity changes in the brain after stroke. In addition, for both spinal cord injuries and stroke patients, exoskeleton-assisted rehabilitation has shown promise in promoting neuroplasticity and as well as some degree of motor recovery.

Three emerging trends in exoskeleton development have caught my eye:

1. The integration of advanced sensors and artificial intelligence (AI): Exoskeleton developers are increasingly integrating advanced sensors and force sensors, along with artificial intelligence, to enable intelligent features such as gait phase detection, terrain adaptation, user intent recognition, and model-predictive control for optimizing power output and torque assistance.
2. The development of soft, lightweight exoskeleton designs: These soft exoskeleton designs aim to improve user comfort, reduce metabolic costs, and enable a wider range of natural movements.



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3. Expansion into industrial applications: industrial exoskeletons are being adopted to reduce worker fatigue, increase lifting capabilities, and prevent workplace injuries in manufacturing, construction, and logistics sectors.

In summary, wearable exoskeleton technology holds immense promise in revolutionizing mobility and independence for individuals with physical disabilities, empowering them to regain the ability to walk, stand, and perform daily activities with greater ease and dignity. Given the profound life-changing potential of this rapidly evolving field, continued research, innovation, and investment from both public and private sectors are crucial to accelerate the development and adoption of affordable, user-friendly exoskeleton solutions that can transform lives on a global scale.