Docket #: S25-344

Compact, responsive, scalable pneumatic control for precise pressure modulation in wearable haptics

Stanford researchers in the CHARM Lab have developed a compact pneumatic control system for precise pressure modulation in for wearable, multi-device haptic systems and smart textiles. Unlike conventional centralized approaches, the distributed control architecture empolys autonomous actuator modules, each with its own embedded controller, sensor, and proportional valve, that are coordinated by a lightweight central controller. The result is highly responsive, low-latency, controllable, smooth and stable pressure feedback. The CHARM lab modular pneumatic control system offers superior quality, comfort, and performance for shared haptic experiences, remote teleoperation, wearable haptic suits, assistive exosuits, virtual reality gloves, and soft robotic interfaces.

Prototype User Demonstration
(Image courtesy the Charm Lab)

Stage of Development – Prototype

Applications

- **Wearable haptic** feedback systems for:
  - **Robotics**
  - **Rehabilitation** devices and prosthetics
  - Surgical and medical **teleoperation**
  - **Smart textiles** with programmable tactile feedback for sports and safety
  - Immersive **AR/VR** suits
  - **Smart garments** for sports and safety

Advantages

- **Highly responsive**, low-latency, stable, and smooth
- **Fine-grained pressure control**
- **Simplified scalability** through modular design, which supports hot-swapping of actuator units
- **Wearable / mobile** and high-performance
- **Wireless multi-device integration** for shared haptic experiences and remote teleoperation
- **Robust**, quiet and efficient

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