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ABSTRACT:

The emphatic interface: Bridging the Human device Divide through HCD in Prosthetics

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Despite major technological advances in prosthetics - ranging from myoelectric control to osseointegrated attachment and bidirectional neural interfaces - clinical adoption and sustained use remain constrained by mismatches between device capabilities and users' lived needs. This paper proposes the concept of an emphatic interface: prosthetic systems intentionally designed through human-centered design (HCD) to foreground empathy, embodiment, and co-creation, thereby bridging the human–device divide. We synthesize evidence across usability research, control paradigms, sensory feedback, attachment systems, affective computing, and clinical outcomes. We then present an HCD-informed framework organized around five pillars—(1) Situated Understanding, (2) Co-Design and Participatory Methods, (3) Emphatic Sensing and Feedback, (4) Adaptive Control and Learning, and (5) Longitudinal Experience and Ecosystem Fit—translating these into practical design guidelines and validation metrics. Case exemplars illustrate how emphatic interfaces leverage structured ethnography, inclusive ergonomics, graded sensory feedback, low-friction retraining, and psychosocial supports to elevate acceptance, reduce cognitive load, and improve functional and affective outcomes. Finally, we outline research priorities in multimodal empathy-aware sensing, personalized neurohaptics, and standards-aligned evaluation. This work reframes prosthetics as responsive partners rather than tools, centering the person's agency, identity, and everyday context.
Keywords : Human-Centered Design (HCD), Prosthetic Interfaces, Sensory Feedback, Adaptive Control Systems, User Acceptance in Prosthetics