Using Mediated Reality to Induce Sensorimotor Impairments

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ABSTRACT

We address sensorimotor impairments induced with Mediated Reality (XYR) [11] for people without impairments. Intentionally inducing impairments, in ways that are controllable, programmable, and adapted to the user and context, can help to better understand challenges faced by people with disabilities caused by real impairments. Examples include computer devices that mediate perception and action to restrict or even refuse movement of a body part or perception via a sensory channel, *e.g.*, an exoskeleton that limits the grasping range of the hand [10] or a head-mounted display that restricts the field of view [4] on purpose. To this end, we use two prototypes: AlterBend, a finger-augmentation device that puts the index finger into a state of controlled hyper-extension making it difficult to bend the finger, and AlterSee, a head-mounted display application for mediated vision, which employs visual filters to modify users' visual perception of the real world. Next, we briefly describe these prototypes and their uses for inducing sensorimotor impairments:

- Kinesthesis is the perception of the position and movement of the body [1]. AlterBend leverages kinesthesis to deliver user feedback via movements of the finger, performed outside the user agency, in the context of on-body interaction. We built AlterBend with a Hitec HS-422 servomechanism affixed to a 3D-printed platform worn on the back of the hand and connected to the fingertip via a nylon wire passing through several stabilizing parts. Using AlterBend, several motor impairments can be induced, including: involuntary movements of the index finger while the hand is at rest, difficulties in manipulating objects that involve the index finger, or even refusal of touching, pinching, and grasping actions by not allowing the index finger to bend. Correspondences with real impairments are represented by people who experience difficulties in coordinating movements [2,3].
- AlterSee is built on FlexiSee [4], a HoloLens application that applies visual filters to the video frames captured by the HoloLens integrated camera, which are then superimposed over the user's field of view to mediate visual perception of the real world. AlterSee implements several visual filters informed by prior work from assisted vision, *e.g.*, edge highlighting [5,6,7], color correction [8], and contrast and brightness adjustment [9], but uses them for inducing impairments instead of compensating or correcting them. Also, different from other assisted vision systems, AlterSee enables remote viewers to control the parameters of the various filters, such as the amount of brightness adjustment, via a web-based user interface. AlterSee can be used to induce various types of visual impairments, *e.g.*, simulated cataract, a narrow field of view, poor contrast perception, etc.

Both AlterBend and AlterSee are examples of Mediated Reality (XYR) technology, but also of wearable systems that implement different types of Sensorimotor Realities (SRs) [12] by affecting user perception and motor action. We are interested in devices, applications, and systems that induce such effects for people without impairments to inform better design of assistive computer systems that can aid perception and/or motor action for people with real impairments.

ACKNOWLEDGMENTS

This work was supported by a grant of the Ministry of Research, Innovation and Digitization, CNCS/CCCDI-UEFISCDI, project number PN-III-P4-ID-PCE-2020-0434 (PCE29/2021), within PNCDI III.

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