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Keio University

Thesis Abstract

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Thesis Title

Convex Interactions: Towards Efficient Human Motion in Peripersonal Space Using Virtual Reality

Thesis Summary

This thesis delves into the concept of Convex Interactions, an interaction mechanic that supersedes our natural interactions in physical space. It leverages our understanding of intimate proxemics and peripersonal space to shortcut interactions, both spatially and through exploration of bodily mapping, to create a more efficient and intuitively superior form of interaction then what we are used to. To understand this motion more, virtual reality technology and physiological signal sensing is used to design and understand these new ways of motions. The main parameters that will be tested in the design of Convex Interactions are the space type, interaction type, mapping type, motion type, and output type. Furthermore, this work explores how the presence of peripersonal neurons in the brain and the link between its neuroplasticity and our peripersonal plasticity as the reason for our ease of adoption in these motions. It was found that motions closer to the core of our body allows us to perceive them as being more intuitive, and the previously mentioned parameters can be used by engineers/designers/researchers to create more forms of Convex Interactions. For the near future, Convex Interactions’s contributions are towards the ubiquitous future of VR technology, where it can promote VR use in more social spaces and reduce the risk of personal space intrusion. However, Convex Interactions’s main vision is to prepare humans for a future where humans marry machines further for more efficient task completion. The knowledge from this work can contribute towards the design of future human augmentation machines.

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A human's everyday interactions with the environment and each other are the product of many years of evolution, as we understand the spaces around us and decide how best to perform the appropriate motions and gestures that are befitting for every scenario. These interactions that we perform are out of intuition; the way our legs move to propel ourselves forward, the way our fingers close when grasping, and so on. These movements have become so natural that, we rarely question the possibility of the next form of interaction that could possibly be more efficient that what we deem natural. However, with the advancements in human-computer interaction (HCI), technology can be used to help us design and develop interaction mechanics that could possibly shape how we perform all our interactions for the better as man marry machine.

To understand this, I look into the concept of space and bodily mapping to define new motions and gestures for everyday interactions. Convex Interactions, defined in this thesis, are interaction mechanics that utilize our proxemic and peripersonal space sense to shortcut interactions, both spatially and through exploration of bodily mapping, to create a more efficient and intuitively superior form of interaction than what we are used to. I used virtual reality (VR) and physiological signal input as a tool to design Convex Interactions. I explore 1) the possibility of shortcutting an interaction that normally involves multiple gesture into only one by reducing the space of interaction to within the intimate space of the user, 2) how different mapped input of a motion can still correlate with what we perceive as natural yet more space efficient, 3) how further reducing the space of interaction to within the peripersonal space while directly changing the output still can feel intuitively superior, and 4) other forms of human interaction that can benefit from this increased efficiency and shortcut in interaction. Finally, I discuss possible scenarios where Convex Interactions can be used beyond VR and as the next evolution of human input and interaction with the use of human-assisted machines through extending body schemas and micro movements.