

Addressing Philosophical, Physical, and Technological Questions in the Creation of Micro-gestures

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ABSTRACT

In Human-Computer Interaction, micro-gestures are often referred to as small, subtle, and rapid physical movements (usually of the fingers or hand) used to control devices, that can be executed in the range of 1 to 4 seconds. Micro-gestures are part of micro-interactions, which are assumed to be short-time interruptions of a primary interactive task to accomplish an auxiliary action. As micro-gestures have become a full area of research and a first-class citizen for gestural interaction, we reflect on three philosophical, physical, and technological questions in their creation and usage as an example of general questions for any interaction. Our philosophical question is: if micro-gestures become a primary means of interaction, to what extent do they blur the boundary between intentional human action and micro-gesture recognition, and how might this reshape our understanding of agency and autonomy? Our physical question is: what are the biomechanical and perceptual limits of micro-gestures, and how can we distinguish micro-gestures from involuntary movements? Our technological question is: how can sensing technologies and recognition algorithms be designed to accurately detect and recognize micro-gestures in real time while ensuring robustness across diverse contexts of use?

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Introduction

Human-Computer Interaction (HCI) has progressively moved from explicit input devices toward increasingly direct forms of interaction with the human body. Keyboard keys, buttons, pointing devices, touch surfaces, speech, gaze, body motion, and physiological signals have successively expanded the range of possible interaction channels. Gesture interaction [1] occupies a particularly interesting position in this evolution because it uses movements that humans can already produce without necessarily manipulating a physical control.

Within this broad space, *micro-gestures* have emerged as a particularly subtle form of gestural interaction. They are commonly associated with small and rapid movements of the fingers or hand that can be performed without substantially interrupting an ongoing activity. Wolf et al. [2] introduced a systematic treatment of micro-gestures in the context of microinteractions, emphasizing that gestures should permit a secondary task without interfering with a primary task and should require limited motor and cognitive resources.

The importance of micro-gestures has increased with the emergence of smartwatches, smart rings, head-mounted displays, smart glasses, wrist-worn sensors, earbuds, and other wearable technologies. These devices create situations in which

conventional interaction techniques are inconvenient or socially inappropriate. A user may be walking, carrying an object, operating a vehicle, manipulating a tool, working in an industrial environment, or interacting with an augmented-reality display. In such situations, reaching for a screen, speaking aloud, or performing a large arm gesture can be disruptive. A subtle finger movement can potentially provide an alternative. Yet the very characteristic that makes a micro-gesture attractive—its subtlety—also creates a fundamental design problem. A large gesture is relatively easy to identify as an intentional interaction. A person who deliberately waves an arm, points toward an object, or performs a large swipe is visibly doing something. A micro-gesture is different. A slight thumb movement, finger tap, rubbing motion, pinch, rotation, or deformation can simultaneously be:

- (a) an intentional interaction;
- (b) an ordinary motor action;
- (c) a preparatory movement;
- (d) a compensatory movement;
- (e) an unconscious or involuntary movement; or
- (f) a movement that the sensing system happens to interpret as an interaction.

Consequently, creating a micro-gesture is not equivalent to selecting a convenient movement and training a classifier. This paper therefore proposes that micro-gesture research should address three questions simultaneously:

- **Philosophical:** What makes a bodily movement an intentional interaction rather than merely a movement?
- **Physical:** What movements can humans reliably, comfortably, and repeatedly perform under realistic constraints?
- **Technological:** What movements can sensing and recognition technologies reliably detect and distinguish from everything else?

References

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