eHenna: A Topology-Centered Taxonomy of Geometry-Defined Finger Input on Skin and Glove Conductive Interfaces

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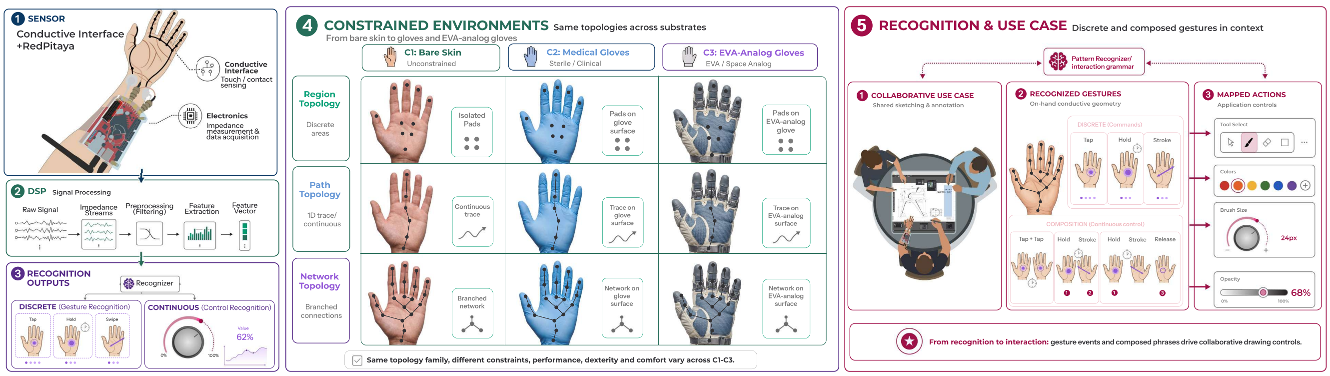

Figure 1: Overview of eHenna as a topology-centered design space across conductive layout classes, substrates, and interaction compositions.

Abstract

Microgestures are subtle finger interactions that can often be performed eyes-free through proprioception. Yet most microgesture sensing systems treat them as discrete gesture classes, while continuous input, such as sliding the thumb along the index finger to control volume, requires stable position mapping over time and is harder to sense precisely. We introduce eHenna, a conductive-ink-based approach for prototyping geometry-defined finger input on skin and glove substrates. In eHenna, finger contact perturbs a known conductive layout, allowing drawn geometries to support both discrete events such as touch, tap, and hold, and continuous controls such as strokes and slider-like movement. This poster frames eHenna as a three-dimensional design space: layout topology (*Region*, *Path*, *Network*), environmental constraint from bare skin to medical and EVA-analog gloves, and composition of discrete and continuous inputs into sequential or interwoven phrases. We present eHenna as a topology-centered design space and taxonomy for discussing how drawn conductive layouts shape possible interaction vocabularies.

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CCS Concepts

• **Human-centered computing → Interaction techniques**; *Gestural input*; *Interaction design theory, concepts and paradigms.*

Keywords

conductive on-skin interfaces; geometry-defined interaction; microgestures; continuous finger input; gesture composition; gloved interaction; topology-centered taxonomy; impedance sensing;

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1 Introduction and Related Work

Microgestures are quick, subtle movements usually performed with the fingers [19] and offer low-effort [10, 21], eyes-free [2, 28], and socially acceptable [20] interaction possibilities. Most microgesture interaction studies focus on classifying discrete microgestures [10], partly because continuous interaction requires sensor signals that change consistently with movement and can be mapped precisely over time. Although technologies such as radar [1, 3, 4, 6, 9, 17], capacitive sensing [16], ultrasound sensing [14], and especially vision-based sensors [25] such as cameras have been used to recognize microgestures, they have primarily supported discrete gesture recognition rather than continuous gesture input.

On the sensing side, conductive on-skin interfaces offer one route to this problem because they place a known, touchable geometry directly on the interaction surface [23, 24]. Such layouts can make input physically anchored, visible or tactile to the user, and less dependent on external sensing conditions than free-space recognition. Prior systems such as iSkin [22], DuoSkin [11], SkinMarks [23], Tacttoo [24], and BodyPrinter [8] show that conductive layouts can be flexible, conformal, decorative, tactile, and rapidly fabricated on the body [8, 11, 22–24]. More recent work extends on-skin fabrication through freehand drawing, woven materials, thread-based structures, and sweat-sensing interfaces [15, 18, 26, 27]. These systems establish feasibility, but they usually couple a fabrication or sensing technique with a small set of demonstrated interactions rather than systematically examining the design dimensions of microgestures. As a result, it remains unclear how the interaction space changes as the conductive design changes.

On the taxonomy side, frameworks such as iFAD [20] explore the design dimensions of micro- and macro-gestures from the perspective of execution, describing how gestures vary from the finger level to the hand, arm, and body levels. μGlyph [7] resolves naming ambiguities in gesture labels such as *tap*, *hold*, and *press* through a formal notation. Lambert et al. [12, 13] examine how microgestures can be visually represented and discovered by users.

Across both existing taxonomies and on-skin interaction studies, a gap remains in the systematic exploration of design dimensions: how the interaction space changes with on-skin augmentation, how interactions are affected when skin-based augmentation is transferred to another substrate, and how interaction composition [5] changes across augmentations and substrates.

To study this gap, we propose eHenna as a design space for systematically exploring ink topology from Region, to Path, to Network; environmental constraints from bare skin, to medical gloves, to EVA-analog gloves; and interaction composition from discrete and continuous microgestures to interwoven discrete-continuous microgestures.

2 eHenna Interaction Family and Backbone

We define eHenna interactions as finger contacts and motions performed on a drawn conductive geometry on the touchable exterior of skin or gloves. The definition is broad across substrates and fabrication methods, but narrow in requiring a known conductive layout on the interaction surface; it excludes free-space-only gestures and sensing that does not rely on surface geometry.

The backbone of eHenna is the *topology scale* at which the conductive layout makes a sensed state distinguishable. This mirrors iFAD's [20] use of body scale as an integrating dimension, but shifts the viewpoint from what the user can articulate to what the interface can resolve. In our setting, the relevant state is geometry-relative: which region is active, where along a trace contact occurs, or which branch of a network is engaged. This is the technical reason a topology-centered taxonomy is warranted.

The taxonomy is designed around four criteria derived from the project goal of reusable, evidence-seeking prototyping: states should be *interpretable* for calibration and debugging, *generative* for designing new layouts, *composable* for building richer controls from simple events, and *comparable across regimes* so the same layout can be studied from skin to gloves.

3 A Topology Taxonomy of eHenna Interactions

Region layouts use discrete conductive areas. Their sensed state is region occupancy over time: which area is contacted and for how long. A tap is a short occupancy event, a hold is sustained occupancy, and repeated taps are temporal patterns over the same state. Region layouts support discrete commands but not intrinsic position tracking.

Path layouts use continuous conductive traces. Their sensed state is position and motion along a one-dimensional path. Strokes, reversals, and slider-like control become plausible because the layout provides a spatial gradient that can be estimated. The distinction from Region is topological: a set of isolated pads cannot provide path-relative position because no connected path exists to invert.

Network layouts use branched conductive geometries. Their sensed state includes branch choice, junction approach, and route. Networks generalize paths by adding topological alternatives, but they are also more likely to degrade under calibration drift, coupling variability, or reduced dexterity.

Composition describes how discrete microgestures and continuous movements can be combined over time. In a sequential composition, a user performs one microgesture after another; for example, a tap can select an action, and a following stroke can set a continuous value for that action. In an interwoven composition, one input changes the meaning of another. For example, in a Network topology on the ring finger, a user may slide downward along a path to set a scale value and then choose a branch at the end of the path to determine where that value is applied: the right branch could apply it to volume, while the left branch could apply it to brightness. These compositions are only possible when the underlying layout can reliably distinguish the required states.

4 Discussion and Expected Contribution

This poster proposes eHenna as a topology-centered design space for geometry-defined finger input. It supports systematic exploration of three linked dimensions: 1) how discrete and continuous microgesture elements compose into richer interactions, 2) how interaction vocabularies change across layout topologies from *Region* to *Path* and *Network*, and 3) how these possibilities shift when the same conductive layouts move from bare skin to medical gloves and EVA-analog gloves.

The expected contribution is a taxonomy and design-space framing that helps researchers navigate these dimensions when designing, comparing, and evaluating on-body conductive interfaces. By connecting layout topology, substrate constraint, and interaction composition, eHenna makes it easier to reason about which interactions are possible, which remain usable, and where usability may degrade as sensing, dexterity, and tactile feedback change across increasingly constrained environments.

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