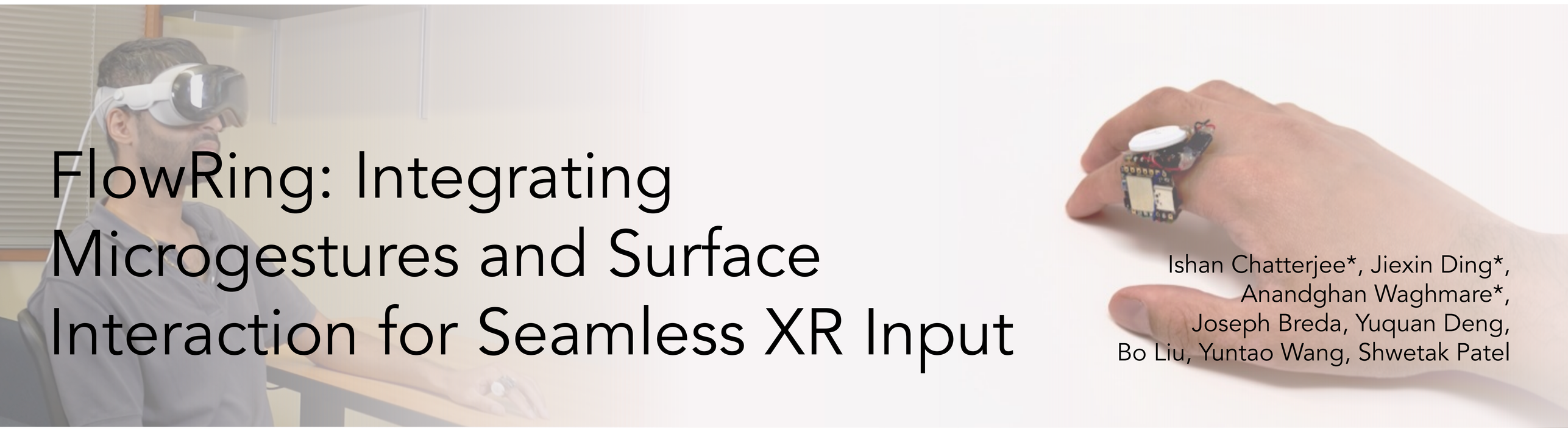

FlowRing: Integrating Microgestures and Surface Interaction for Seamless XR Input

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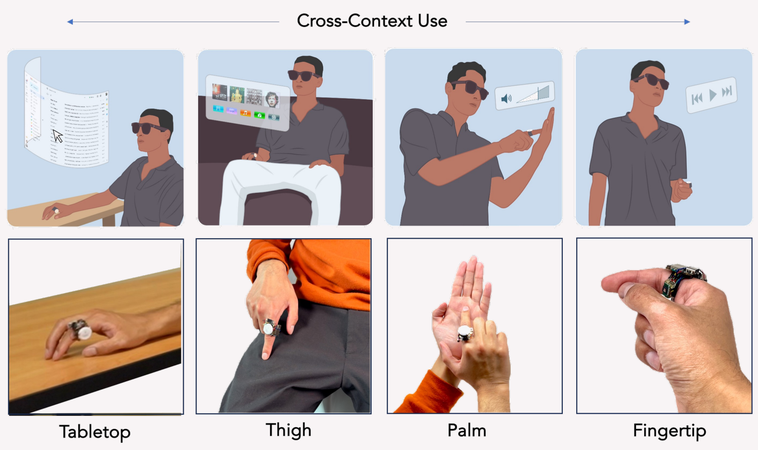
Motivation

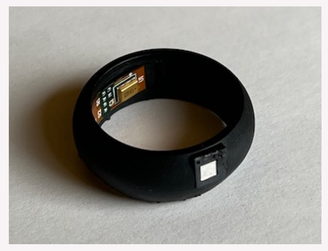


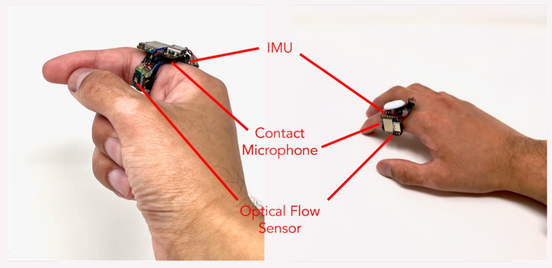
As Extended Reality (XR) advances, a device has the potential to be used **across contexts** from immersive productivity at a desk to on-the-go, public scenarios.

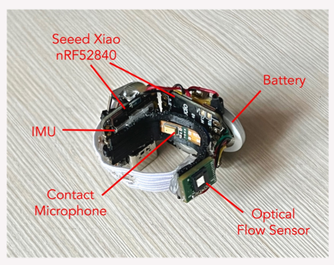
Current input devices **lack this necessary versatility**. We introduce FlowRing, a novel **ring-form factor** device designed to bridge the gap between the **high-throughput, ergonomic input** of stationary devices and the **subtle, portable control** needed for mobile XR applications. FlowRing supports a dual-mode interaction paradigm: on-the-go input is facilitated by **five subtle microgestures**, while richer, higher-throughput interactions are enabled through **2D continuous input and tapping on surfaces**, akin to a mouse.

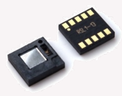
Prototype

FlowRing consists of three main sensing components: an optical flow sensor, a contact microphone, and a 6-DOF IMU.

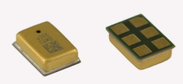








Optical Flow Sensor (Pixart PAT9130)



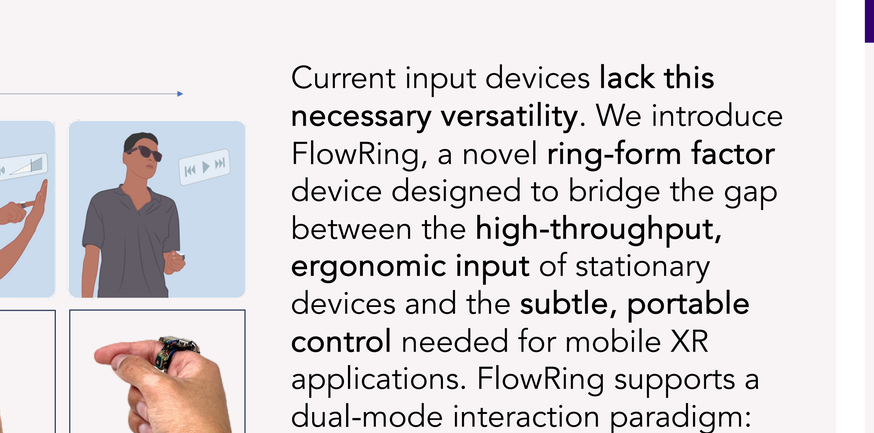
6-Axis IMU (Accel + Gyro) (ST LSM6DS3TR-C)

Contact Microphone (Knowles V2S200D)

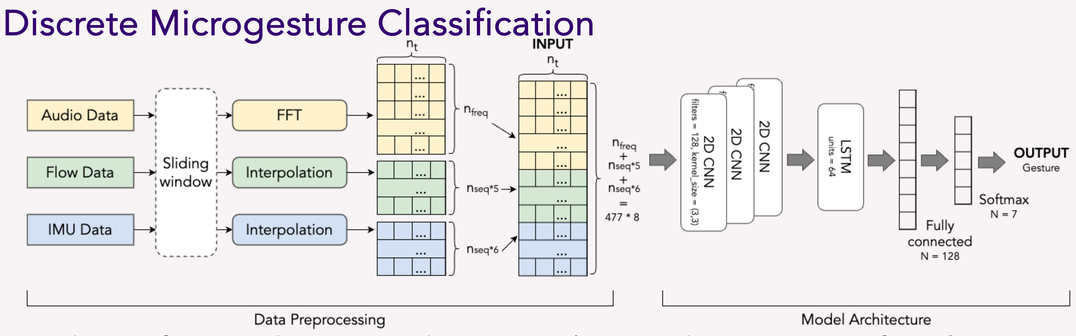
Seeed Xiao nRF52840 Sense

Method

A **gating classifier** rejects false positives from daily tasks and determines if the user performed a gesture or is holding their hand over a surface. If it is a gesture, the **discrete microgesture classifier** then determines the type of gesture. If it is a mouse-like action, the gating model can then engage a **continuous 2D on-surface tracking**.



Discrete Microgesture Classification

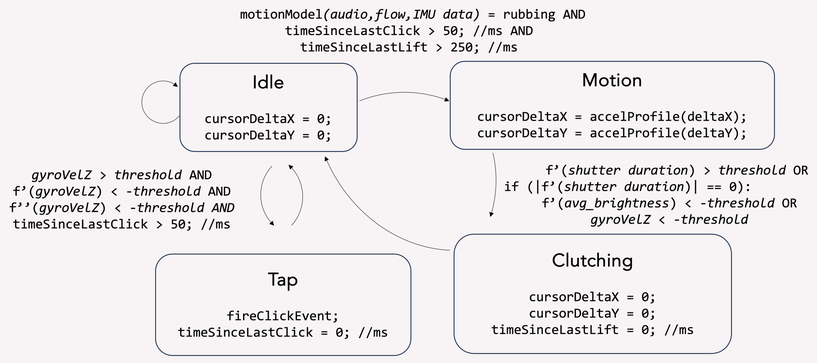


We detect five quick gestures by a neural network consisting of a 3-layer CNN and an LSTM. To improve the accuracy of detection, we fused data from a contact microphone, an optical flow sensor and a 6-DOF IMU.

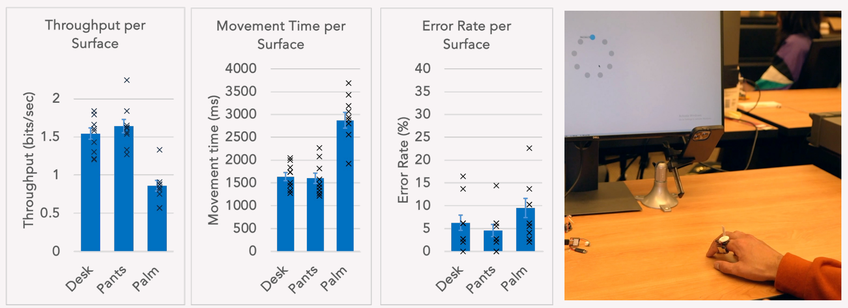
FlowRing achieved 93.6% microgesture recognition accuracy across sessions and 85.2% across unseen users, rising to 90.1% with just four gesture set examples from a new user.

Continuous 2D On-Surface Tracking

We attempt to emulate the feel of a trackpad by combining both heuristic-based and learned methods.



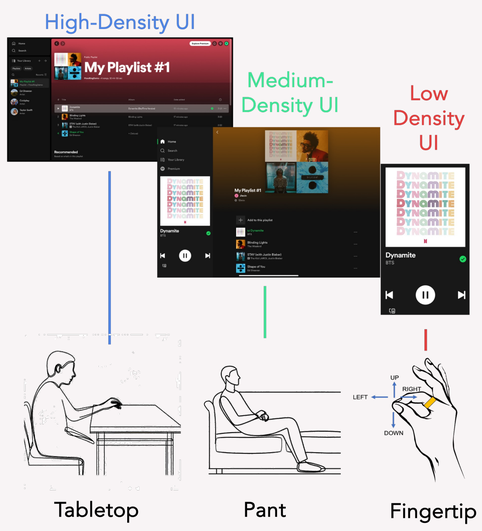
Participants felt tracking was quick and intuitive on desk and pants in 2D Fitts'-style evaluation.



Applications

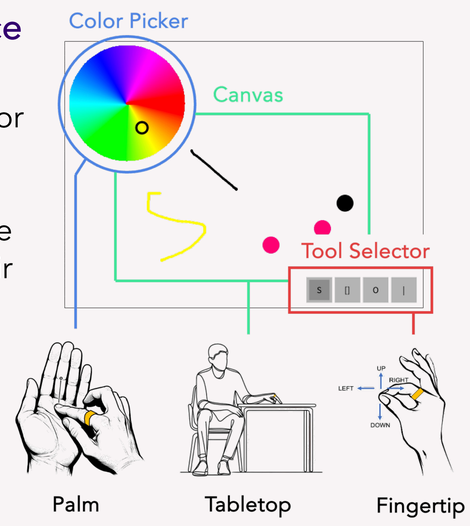
Cross-Posture Control

As users leverage a given computing device in different scenarios, their posture may change with use. The UI will adapt to users' posture.



Cross-UI Affordance Control

Within an application or digital environments, multiple controls can be mapped to multiple surfaces based on their affordances.



Cross-Device Control

Users now commonly interact with multiple devices concurrently. Different devices can be associated with interactions on different surfaces.