Flexible NFC wristband for ultralow-power ring-to-wristband interaction

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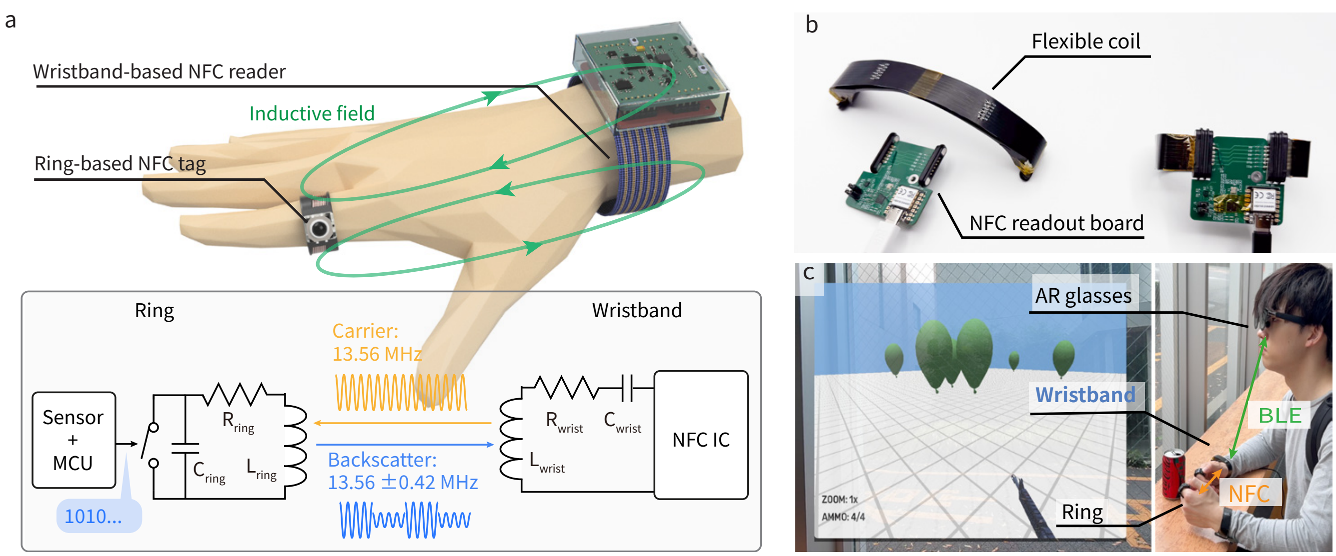

Figure 1: Overview of the flexible NFC wristband. (a) Schematic of the ring-to-wristband interaction. (b) Prototype of the flexible NFC wristband. (c) Demonstration of a first-person shooting game on AR glasses.

Abstract

Advances in HMDs and AR glasses enable intelligent wearable interaction even in outdoor and public situations, creating a need for input devices that are subtle and wearable all day. Smart rings are a promising form factor because they sense microfinger input reliably, but their tiny battery cannot sustain power-hungry electromagnetic radios such as BLE for continuous use. To remove such a wireless burden, we shift it off the ring onto the wristband: the ring communicates with only the nearby wristband through a short-range NFC link, and the wristband, which can hold a larger battery, relays the ring's input data to the glasses with BLE. Building on our previous picoRing project on ring-to-wristband inductive communication, we present our latest picoRing, enabling a flexible NFC wristband to capture the tens of kbps-class high-speed data unlike the previous slow-speed picoRing. By combining NFC Type-V technology with our sensitive coil design, the wristband can capture the high-speed motion signal and trackball input from the ring, while the ring can maintain an ultralow-power design. The ring side consumes only 0.86 mW and lasts about 100 h on a 20 mAh charge, pointing toward fully soft, body-scale NFC wearables that connect rings, wristbands, and glasses.

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CCS Concepts

• **Human-centered computing** → **Interaction devices**; • **Hardware** → **Wireless devices**.

Keywords

flexible electronics; NFC; coil; wristband; ultralow-power wearables; smart ring; everyday AR

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1 Introduction

Smart glasses, such as head-mounted displays (HMDs) and AR glasses, are bringing digital content into our daily lives, but they still demand input devices that are subtle, socially acceptable, and wearable for long periods. Smart rings place sensors directly on the finger and reliably capture subtle finger inputs. Their main limitation is power: a ring offers only a tiny battery, yet always-on active radios such as BLE draw a 10 mW-class current that drains a 20 mAh battery within a few hours.

Our position is that the ring should not carry this long-range wireless burden: instead, it talks to a nearby wristband over a short-range NFC link, and the wristband—which can hold a larger battery—relays the input to the AR glasses. We build on our previous picoRing, which established ultralow-power ring-to-wristband inductive communication but was restricted to a slow, frequency-sweeping readout [1, 4]. This paper focuses on a *flexible NFC wristband* that lifts this data-rate limit while keeping the ring ultralow-power, and demonstrates it driving AR glasses end to end. Hardware, firmware, and a demo video are available at https://github.com/KawaharaLab/ISWC2026_picoRingdual.

2 Flexible NFC wristband design

The wristband consists of a 5-turn flexible resonant coil mounted on a 3D-printed flexible band, together with a readout board carrying an NFC reader IC (ST25R3916B, STM) and an MCU (XIAO nRF52840, Seeed Studio) (Figure 1b). The coil captures the load-modulated backscatter from the ring's NFC tag, the reader IC decodes the BPSK-encoded packet on the 13.56 MHz carrier, and the MCU relays the recovered finger input to the host over BLE. Unlike the frequency-sweeping readout of the previous picoRing, this load-modulation scheme streams motion and trackball data at a tens-of-kbps rate, fast enough for responsive interaction.

Standard wristband reader coils use few turns and low self-inductance (L_{wrist}) to prioritize impedance matching. In contrast, we increase the number of turns to maximize L_{wrist}, thereby boosting the reader's sensitivity to the subtle load changes caused by the ring. When the ring tag modulates its impedance (ΔZ_{ring}), the input impedance looking into the wristband coil (Z_{in}) changes according to the mutual inductance ($M = k\sqrt{L_{\mathrm{ring}}L_{\mathrm{wrist}}}$): $Z_{\mathrm{in}} = Z_{\mathrm{wrist}} + (\omega M)^2/Z_{\mathrm{ring}}$, where Z_{wrist} and Z_{ring} are the inherent impedances of the wristband and ring coils, and ω is the angular frequency of the carrier. By maximizing L_{wrist}, the $(\omega M)^2$ term scales higher, so the variation in Z_{in} stays large enough to demodulate even when k is low due to distance or misalignment. We further adopt NFC Type-V (ISO/IEC 15693), whose narrow bandwidth lowers the receiver noise floor so the link holds up to 12.0 cm, covering a standard hand size. With $Q = 9$ and $L_{\mathrm{wrist}} = 3.2\,\mu\mathrm{H}$, the heavy readout stays on the wristband so the ring runs at only 0.86 mW for about 100 h on a 20 mAh battery.

3 Toward fully soft, body-scale readers

The present wristband is a useful midpoint rather than an endpoint: the coil and band are flexible, but the readout board is still rigid. We see a clear trajectory toward a fully soft reader. First, the rigid readout electronics can migrate onto e-textiles, so the wristband becomes garment-integrated and conformal [5]. Second, the single-wrist reader generalizes to a body-scale near-field network in which meandered textile coils read multiple on-body tags at once [3, 6]. Together, these steps move toward the intelligent soft wearable ecosystem [2, 7], with soft, body-scale NFC connecting rings, wristbands, and glasses.

4 Demonstration

We demonstrate the flexible NFC wristband driving AR glasses end to end. Input from each ring's trackball and IMU is sent to the wristband over NFC, forwarded to a host over BLE, and displayed on XREAL One AR glasses (Figure 1c). Our running demo is a first-person shooting game: a user drives locomotion with one hand's trackball while aiming with the other hand's IMU, giving bimanual control comparable to handheld VR controllers in a fully wearable form factor and without occlusion. Visitors can put on the rings and try the bimanual control themselves at the booth.

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