Demonstration of VisRing: A Display-Extended Smartring for Nano Visualizations

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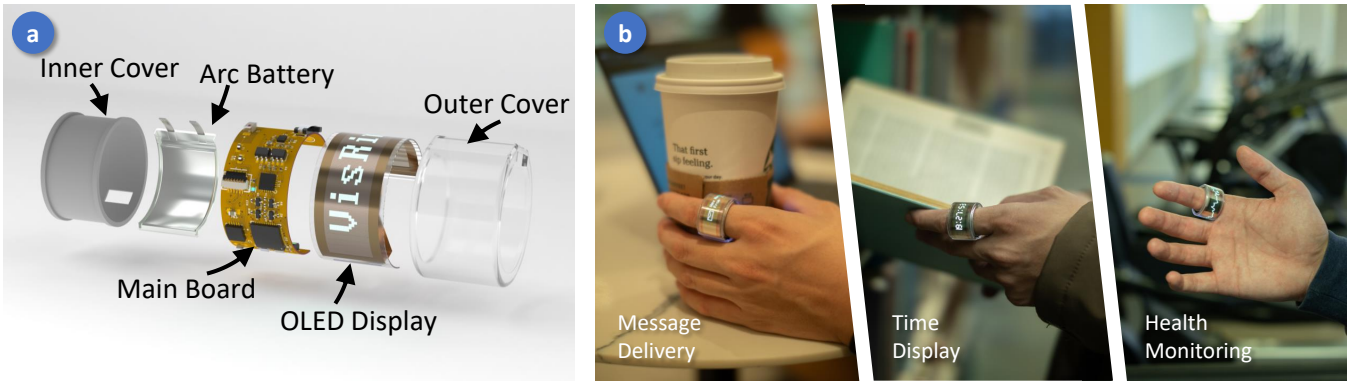

Figure 1: *VisRing* [12] is a smartring integrated with sensors, a bendable display, and an accompanying firmware library. (a) An exploded view of the smartring. (b) *VisRing* integrates sensing and a bendable display into a compact ring form factor, enabling nano visualizations such as message delivery, time display, and health monitoring. VisRing demonstrates the feasibility of display-equipped smartrings and the novel opportunities they provide.

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Abstract

We demonstrate VisRing [12], the first smartring incorporating a bendable 160 × 32 4-bit grayscale organic light-emitting diode display. VisRing stands out by displaying nano visualizations while maintaining a compact design and minimal weight of 6.6 g, with an overall cost of around $35. We exploit opportunities for a system-on-a-chip architecture to tightly integrate an inertial measurement unit, a photoplethysmograph sensor, a temperature sensor, Bluetooth, a microcontroller, and a display unit that spans 270° to 360°,

depending on finger size. Our contributions include the hardware design and implementation of VisRing, along with a software library that supports visualizing various data types. A qualitative study with 12 participants demonstrated the comfort, likability, and social acceptance of VisRing's hardware and software. The participants liked the visualizations and found the ring lightweight, but also pointed out possible improvements. We will open-source VisRing hardware and software for further development of interesting usage scenarios. The demo will include a showcase of the VisRing system hardware assembly and hands-on and live testing of various VisRing applications, which include message delivery, time display, and health monitoring.

CCS Concepts

• **Hardware → PCB design and layout**; • **Human-centered computing → Visualization toolkits**; **Mobile computing**.

Keywords

Smartring, Wearable, Sensor, Sensing Application, Micro Visualization, Nano Visualization, Usability Study

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1 Introduction

Wearable devices such as smartwatches and fitness bands continue gaining popularity due to their compact size and unobtrusive design. Advances in semiconductor technology, flexible electronics, and display systems have enabled the development of even smaller and more discreet form factors. Among these, smartrings offer a particularly seamless and low-profile user experience compared to smartwatches. Integrating a display into a smartring facilitates visual access to information while maintaining a significantly smaller and more discreet form factor relative to larger wearables such as smartwatches and smartphones.

Recent trends suggest smartrings are poised to become the next major wearable platform to incorporate smart features. These trends are evidenced by optimistic market projections [8, 21] and ongoing innovations from leading technology companies, including Samsung [5] and Oura [17]. Nevertheless, the current generation of smartrings mainly focuses on sensing functionalities for personal health and fitness applications—such as tracking heart rate, blood oxygen levels, blood pressure, and sleep—where the collected data is transmitted to a smartphone for visualization [6, 11, 13, 19]. In contrast, smartrings that feature integrated visual displays remain scarce [2, 4, 14, 18].

Of the few commercially available smartrings with embedded displays, most are proprietary and provide only rudimentary feedback. These displays are typically limited to simple fixed icons or numeric output due to the use of low-resolution or segmented LED displays or liquid crystal displays [2, 7, 10]. As such, they are incapable of rendering complex visual content like health data visualizations, text notifications, or interactive elements. Although Darbar et al. [4] presented a smartring featuring an OLED display, using a rigid, non-bendable module resulted in a form factor that compromised wearability. In addition, the vast majority of smartrings in both commercial and academic domains lack visualization capabilities. Academic prototypes typically emphasize gesture sensing and finger motion tracking [3, 20, 22–24], or focus on health-related sensing applications [5, 15, 17–19, 24]. To date, no smartring exists that supports a flexible display capable of rendering standard data visualizations such as bar charts, line plots, or progress indicators.

To bridge this gap, we propose a novel smartring platform that integrates a flexible OLED display capable of supporting information-rich visualizations [12]. This work addresses three primary design challenges in the development of such a platform: (i) The compact integration of a high-resolution flexible OLED display, multiple sensors, a microcontroller, and a battery within the constrained space of a ring; (ii) The precise and cost-efficient assembly of flexible displays, printed circuit boards, and batteries into a miniaturized, curved form factor; and (iii) The need for programmability and wireless communication while maintaining a minimal form-factor.

To evaluate the proposed *VisRing* system in the context of health data visualization, we investigate the constraints and opportunities of rendering visual content on ultra-small displays. Prior work on micro visualizations for smartwatches and fitness bands highlights the challenges of balancing miniaturization with readability and glanceability [1, 9, 16]. Building on this foundation, our approach leverages the smartring's discreet and ergonomic positioning to deliver compact visualizations. Specifically, we account for the display's elongated shape and bendable nature, the limited pixel area, and the potential for positioning the screen on the palm side of the finger to enhance privacy. To this end, we introduce the concept of nano visualizations—a class of data visualizations designed specifically for ultra-small, curved display surfaces on smartrings.

2 Demo Applications

We present three applications developed on the VisRing hardware platform and its nano visualization library, which include message delivery, time display, and health monitoring.

2.1 Message Delivery

VisRing connects to mobile devices via Bluetooth Low Energy (BLE) and listens for incoming notifications. During standby, the display remains off to conserve power. Upon receiving a message, a notification icon appears on the display, followed by a brief animated preview of the message content. This demonstration highlights VisRing's support for wireless communication and its capability to render animated, fine-grained visual content on a compact display.

2.2 Time Display

VisRing uses a large, legible font to display the current time with information for hours, minutes, and seconds. While in standby mode, the display remains blank. Time rendering is triggered by a lift-to-show gesture, where the user raises their hand to a natural viewing position. VisRing synchronizes the time with a paired mobile device via BLE upon each cold boot. This demonstration showcases VisRing's support for IMU-based gesture recognition and the rendering of various font styles.

2.3 Health Monitoring

VisRing presents real-time photoplethysmography (PPG) measurements and derived heart rate values. When worn with the PPG sensor in contact with the user's finger skin, VisRing begins measurement upon receiving a command from the mobile device. The device then displays the raw PPG waveform and the calculated heart rate in beats per minute (BPM). All signal processing and heart rate estimation are performed on-device in real time. This demonstration illustrates VisRing's integrated sensing capability and ability to perform real-time physiological signal processing.

3 Conclusion

In this demonstration, we presented VisRing, a novel smart-ring platform integrating multiple sensors and a bendable OLED display for on-body, glanceable data visualizations. Depending on size, the display spans 270°–360° around the finger and supports full grayscale rendering. Our prototype is lightweight (6.6 g), cost-effective ($35), and open-sourced, including both hardware design and a nano visualization library tailored for small, curved displays. We showcased three key applications—message delivery, time display, and health monitoring—each highlighting different aspects of VisRing's interaction, sensing, and visualization capabilities. We introduced the concept of nano visualizations to describe the unique design space of visualizations on such compact and curved displays. Our demo also reflects the technical feasibility and user-facing design of VisRing through real-time interaction and feedback. Moving forward, we aim to extend VisRing's capabilities by supporting low frame-rate displays such as e-ink for improved battery life and by enhancing privacy features to ensure sensitive data remains protected, regardless of viewing context.

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