Augmenting Smartwatch with a Rollable Tentacle

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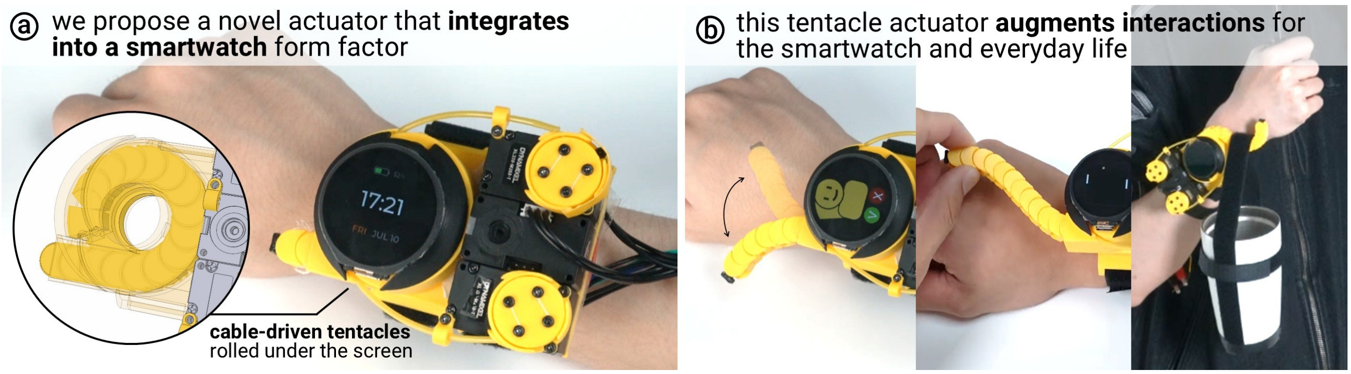

Figure 1: (a) We propose a novel actuator that is rolled under the smartwatch screen. The actuator, which is a custom tentacle actuator, can be extruded to variable length on demand and controlled through cable-driving motors. (b) The actuator can augment interactions for the smartwatch, e.g., extending the display for a phone call as a waving hand, extending the input for playing games, and for everyday life, e.g., helping hold a beverage when hands are occupied.

Abstract

We present a novel tentacle actuator that integrates into a smartwatch form factor. Unlike prior work on tentacle robotics, this tentacle can be rolled into a rounded casing beneath the smartwatch screen, measuring 50 mm in diameter. Motors can extrude the tentacle on demand to a maximum length of 90 mm and control its direction via driving cables. We explore everyday interactions enabled by this new actuator. We demonstrate applications including adding expressiveness to remote communication and navigation cues, providing a tangible controller, and actuating lightweight objects. We envision this prototype as one of the first steps towards embedding robotics in our everyday wearables.

ACM Reference Format:
Ping-Jhao Hsu and Shan-Yuan Teng. 2026. Augmenting Smartwatch with a Rollable Tentacle. In *The 39th Annual ACM Symposium on User Interface Software and Technology (UIST Adjunct '26), November 02–05, 2026, Detroit, MI, USA.* ACM, New York, NY, USA, 2 pages. https://doi.org/10.1145/3830397.3842466

1 Introduction

Smartwatches have become mainstream wearable devices that accompany many users in their daily lives. Their small form factor allows them to be worn for extended periods; however, it also limits their input and output capabilities. Prior work has explored ways to expand the input space beyond the touchscreen, such as detecting gestures of the wrist or touch around the watch, or extending the visual display by projecting onto the forearm [3].

Other research explores dynamically changing the watch's form factor with multiple foldable screens [4]. While this can substantially increase the watch's interactive surface area, the transformation is discrete, offering only a few fixed states (e.g., folded or fully extended) that can feel inflexible for everyday use.

We explore a novel smartwatch form factor that integrates a robotic tentacle capable of extending on demand, as depicted in Figure 1. We propose a new method for coiling the tentacle into a rounded casing 50 mm in diameter, allowing it to store itself when not in use. A motor continuously extrudes the tentacle to variable lengths, up to a maximum of 90 mm. The tentacle design is inspired by [1, 2], and is controlled via cable-driven motors that curl it left or right. This enables the smartwatch to convey additional information, for instance, remaining time through its length, or navigation cues through its direction. The tentacle can also function as a tangible controller, such as for gaming, with haptic feedback provided by the motors. Finally, it can serve as an external robotic finger, actuating lightweight objects or holding them for the user when their hands are occupied.

This is the first standalone tentacle prototype that can be rolled up, and we envision that more compact actuation could be further developed. We believe that our work is a step toward integrating robotics into everyday wearables in a less obtrusive way.

2 Novel Rollable-Tentacle Mechanism

In contrast to prior robotic tentacles that assume a constant length, we propose a method to coil the tentacle and extrude it on demand. This allows the structure to remain less obtrusive when not in use.

UIST Adjunct '26, Detroit, MI, USA

ACM ISBN 979-8-4007-2855-6/26/11
https://doi.org/10.1145/3830397.3842466

Tentacle structure. As depicted in Figure 2, multiple 3D-printed units (PLA) are connected via linkages to maintain rigidity. A flexible core (TPU) running through all units prevents buckling during direction changes, a failure mode common in continuum tentacle actuators that lack such reinforcement.

Extruding and direction control. Three continuous-rotation servo motors (Dynamixel XL330-M288T, 5V) with built-in PID control drive the mechanism. One motor extrudes the tentacle by driving an extrusion head through a transmission gear train, extending it to a maximum length of 90 mm in under one second. The remaining two motors pull cables in proportion to the extension length to control the tentacle's direction. Figure 3 illustrates the process.

Sensing. By monitoring motor current, we can estimate the torque applied by the user, and its direction can be inferred from the relative activation of the two directional motors.

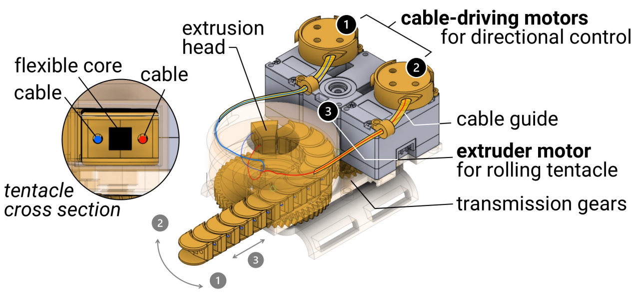

Figure 2: Diagram of the rollable tentacle mechanism.

Figure 3: The tentacle can extend and turn in either direction.

3 Wearable Prototype

The motors are controlled with a BLE/Wi-Fi enabled microcontroller (ESP32-S3). A capacitive-touch rounded LCD screen is used (1.28") as the watch screen. The entire wearable is standalone, powered by a LiPo battery, and weighs 146.6 g (battery: 10g). The watch face is 50 mm in diameter, and the thickness is 44 mm.

4 Application Space

Our rollable tentacle expands the expressivity of smartwatches across four dimensions:

Linear display. The tentacle can serve as an extended display for conveying simple information, with the advantage of being more visible in peripheral vision than the watch face alone. For example, a timer or navigation guidance, shown in Figure 4 (a) (b).

Input device. The tentacle can serve as an input controller, with forces in either direction that can be sensed by the motors. It can be used to navigate the smartwatch or play games, with additional haptic feedback rendered by rolling the tentacle back and forth, as depicted in Figure 4 (c).

Actuation. The tentacle can actuate lightweight objects. For example, automatically pull out a tea bag after a user-defined steeping time when the user is in a conversation, as depicted in Figure 5 (a).

Physical support. The tentacle can also act as a physical support to hold objects, like an extra finger, as depicted in Figure 5 (b). The user can manually trigger this function as needed.

Figure 4: (a) The length of the tentacle represents the remaining time in a Pomodoro timer. (b) The tentacle's direction provides navigation cues. (c) The tentacle serves as a controller to play a Pong game with haptic feedback.

Figure 5: (a) The tentacle acts as an additional "finger" to hold a beverage when the user's hands are occupied. (b) The tentacle pulls out a tea bag when the timer is up.

References

[1] Jiaji Li, Shuyue Feng, Maxine Perroni-Scharf, Yujia Liu, Emily Guan, Guanyun Wang, and Stefanie Mueller. 2025. Xstrings: 3D Printing Cable-Driven Mechanism for Actuation, Deformation, and Manipulation. In *Proceedings of the 2025 CHI Conference on Human Factors in Computing Systems (CHI '25)*. Association for Computing Machinery, New York, NY, USA, 1–17. doi:10.1145/3706598.3714282

[2] Zhanchi Wang, Nikolaos M. Freris, and Xi Wei. 2025. SpiRobs: Logarithmic spiral-shaped robots for versatile grasping across scales. *Device* 3, 4 (April 2025), 100646. doi:10.1016/j.device.2024.100646

[3] Robert Xiao, Teng Cao, Ning Guo, Jun Zhuo, Yang Zhang, and Chris Harrison. 2018. LumiWatch: On-Arm Projected Graphics and Touch Input. In *Proceedings of the 2018 CHI Conference on Human Factors in Computing Systems (CHI '18)*. Association for Computing Machinery, New York, NY, USA, 1–11. doi:10.1145/3173574.3173669

[4] Kening Zhu, Morten Fjeld, and Ayça Ünlüer. 2018. WristOrigami: Exploring Foldable Design for Multi-Display Smartwatch. In *Proceedings of the 2018 Designing Interactive Systems Conference (DIS '18)*. Association for Computing Machinery, New York, NY, USA, 1207–1218. doi:10.1145/3196709.3196713