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# Exploring Wearable Robotic Appendages for Daily Use

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## 1. Introduction

Wearable robotic appendages have a huge potential for everyday use [1,2]. However, there is a gap between envisioned potential applications of wearable robots and current implementations, where aspects like technical complexity, efficiency, and emphasize on industrial or medical contexts forbids their deployment for daily usage applications. Moreover, with the spread of the new coronavirus, there is a need to devise ways to reduce contact with others as much as possible.

Accordingly, this research project focuses on a user-centered approach to exploring novel applications of snake-like wearable telepresence robotic appendages with emphasis on multi-user interactions. In this paper, we introduce and discuss our work on two snake-like robotic appendages, *T2Snaker* and wearable telexistence system (*WTS*). We discuss design, deployment contexts and highlight some design insights for future deployment of these appendages. Lastly, we highlight the future directions for deeper exploration of robotic appendages.

## 2 Wearable Telexistence System (WTS)

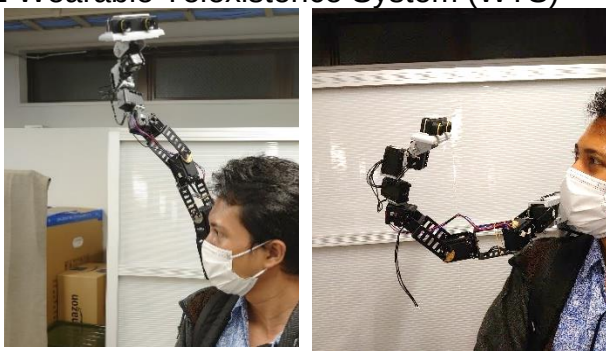

Fig 1 (Left): WTS can be used to observe the environment around the user. (Right): WTS can also be used to interact with the user, such as by talking to them or pointing towards specific objects.

Fig 2 WTS can be used to inspect objects or remote assistance and training applications.

After the corona pandemic, communication with remote users has become an integral part of the world. Although several systems enable verbal and visual communication, physical communication has long been challenging to achieve. Therefore, we introduce WTS, a system comprising a snake-like wearable robot that can be remotely controlled to share experiences with others.

The system comprises a local system and a remote system. The local system includes a head mounted display, tracking system, mic, speakers. The remote site comprises the WTS, which includes a single-board computer unit controlled through Wi-Fi, and an 8 DoF snake-shaped robot with a stereo camera at the end-effector.

The uniqueness of this robotic appendage is the flexibility enabled by its high DoF, which enables remote users to move freely and look around them as if they are in the remote environment.

Several applications can be achieved using our system. For example, users can take a walk together or go shopping, where the users can use the robot arm to flexibility see the environment or inspect objects. Similarly, functional tasks, such as remote inspection or training can be achieved.

## 3. T2Snaker

T2Snaker extends previous works to augment the table tennis learning experience by substituting physical contacts with table tennis coaches with either autonomous or teleoperated robotic appendages [2].

The overall diagram of the system is shown in Figure 3. This system mainly consists of a VR HMD and a robot arm. The robot arm can be worn or mounted in the environment. As shown in Fig 4, the user can practice alone using a table-tennis table set up in the VR space; instructional videos are set up in the VR space, and the trajectory of the ideal swing is visually clarified to incorporate a teaching method unique to the VR space [3]. Also, the robot arm (9 DoF) actuates the tennis racket to guide users' arms like exoskeletons [1]. This robot arm is synchronized with the VR environment, allowing the user to learn the correct swing trajectory, timing, etc.

For synchronization, we used WebSocket messages, a chat server, and a simulator created in Unity, as shown in Figure 5. When a table-tennis ball is launched in the VR space, the angle of the servo motor is calculated in the simulator, and the calculation result is reflected to the robot arm. Our implementation can enable autonomous or teleoperated controls [1].

Fig 3 this figure shows swinging motion assisted by the robot.

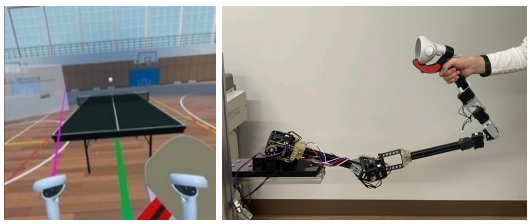

Fig 4 (Left): VR Table Tennis Room (Right): The robot arm is shaped like a snake with more DoFs near the end-effector to enable flexible manipulation of the table-tennis racket.

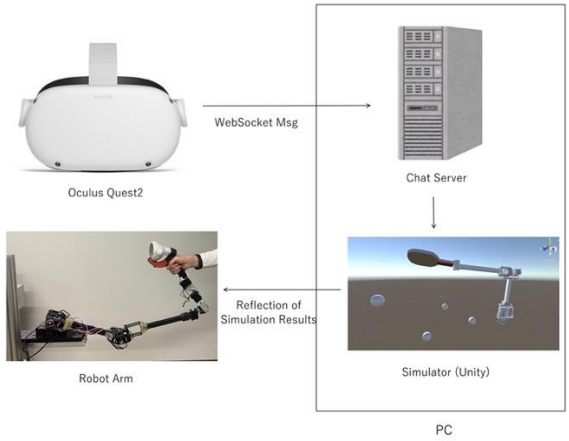


Fig 5 Flow Diagram of the Information.

## 4. Conclusion

This project focuses on exploring novel applications of wearable telepresence robotic appendages within daily interaction contexts. We presented two robotic appendages that are currently being evaluated. Overall, wearable robotic telepresence systems are intriguing and offer unique interaction potentials. Most importantly, they enable physical interaction potentials and embodiment between local and remote users beyond existing systems, such as teleconferencing or audio-visual systems. Therefore, we will focus our future efforts into exploring novel applications enabled by the flexibility of the snake-form factor for telepresence systems.

## 5. Reference

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