

Wearable Robotic Orthosis for Finger Tremor Suppression Using PVC Gel Based Soft Actuators [1, 2]

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Introduction

In 2025, approximately 247 million people worldwide and 2.07 million people in the UK suffer from finger tremors, including essential tremor, Parkinson's disease-related tremor, and other causes.^[3] Medication and surgery pose risks, including side effects and complications, underscoring the need for safer alternatives.^[4]



Fig.1 Impact of finger tremors^[5]

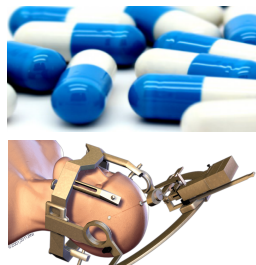


Fig.2 Medication and surgery^[6]

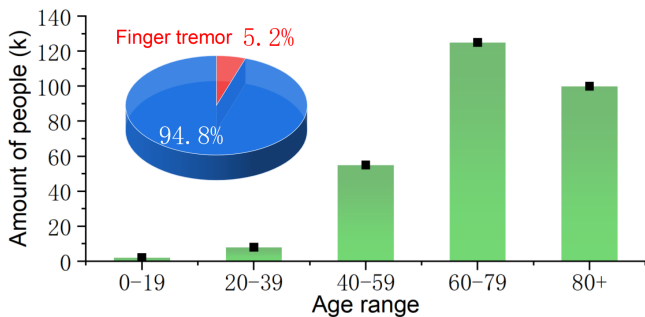


Fig.3 The proportion of people suffering from finger tremors in the UK and the distribution across age groups.

Our work

This work introduces a lightweight (140g) wearable finger tremor-suppressing orthosis, which consists of a self-sensing variable stiffness semi-active absorber (SSVS-SA), an active absorber, and a force sensor (Fig.4).

- It for the first time applies the polyvinyl chloride (PVC) gel actuator as the semi-active and active absorber for tremor suppression.
- It utilizes a self-sensing variable stiffness artificial muscle as the semi-active absorber.
- It can simultaneously detect and suppress tremors regardless of whether the fingertip is vibrating in the air or applying tremor force while in contact with an object.

Acknowledgement

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Reference

- [1] Liu C, Zhang K. "A wearable finger tremor-suppression orthosis." *IEEE Robotics and Automation Letters*, 2024, 4(9): 3854-3861.
- [2] Liu C, et al. "An electric self-sensing and variable-stiffness artificial muscle." *Advanced Intelligent Systems*, 2023, 5(9): 2300131.
- [3] <https://www.nhs.uk/conditions/tremor-or-shaking-hands/>.
- [4] Welton, Thomas, et al. "Essential tremor." *Nature reviews Disease primers* 7.1 (2021): 83.
- [5] The behaviors of tremors. www.google-tremor-figure.tif.com.
- [6] <https://www.barrowneuro.org/treatment/deep-brain-stimulation-dbs/>.

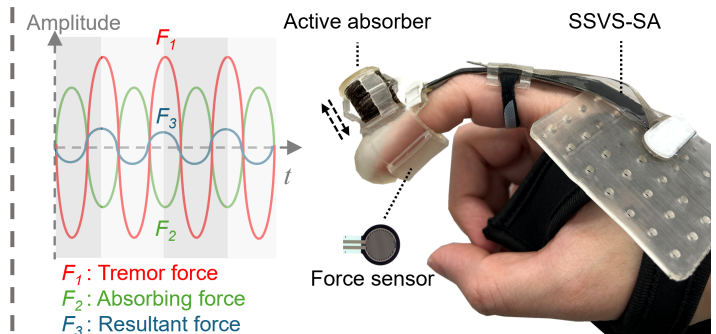


Fig.4 (a) The actuation principle of one PVC gel actuator unit. (b) The schematic and principle of the robotic orthosis.

The tremor suppression process is as shown in Fig. 5.

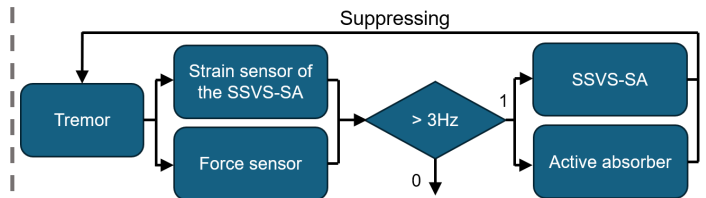


Fig.5 The working flow chat of the orthosis.

Tests and Results

The test result shows the combined semi-active and active control achieves nearly 90% suppression efficiency.

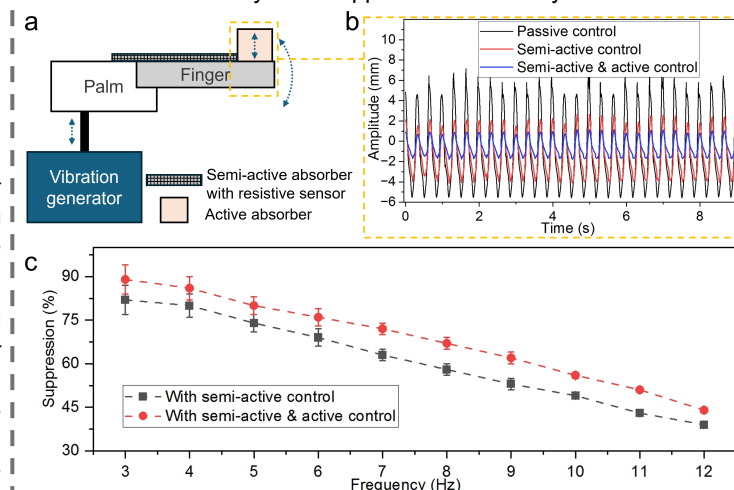


Fig.6 (a) The tremor suppression experimental setting. (b) The result of 3 Hz. (c) Results of various frequencies.