Visual guidance to facilitate a robotic ankle-foot orthosis use

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Introduction

- Wearable robotic devices have emerged as a promising technology in rehabilitation field [1]
- Humans required to adapt the movement with a robotic device to maximize assistance efficacy [2].

Fig.1 Experimental setup

- Otherwise, the robotic devices can result in reduced freedom of the subject's motion which consequently can cause even injuries [3].
- The robotic devices can be more easily learned through sensory feedback similar to rehabilitation devices [4].
- However, a limited study exists [5-6] on a method to help human learning to a robotic device.

✓ The overall aim of the study is to develop visual guidance for human adaptation.

✓ The hypothesis of the study is that the visual guide for a wearable robot, Robotic Ankle-Foot Orthosis(R-AFO), can help participants to use the device by reducing cost of walking.

Methodology

A. Initial concept of the visual guidance

- We developed Graphic User Interface(GUI) (Fig.1), Which was presented to a participants during walking while wearing robotic ankle-foot orthosis.

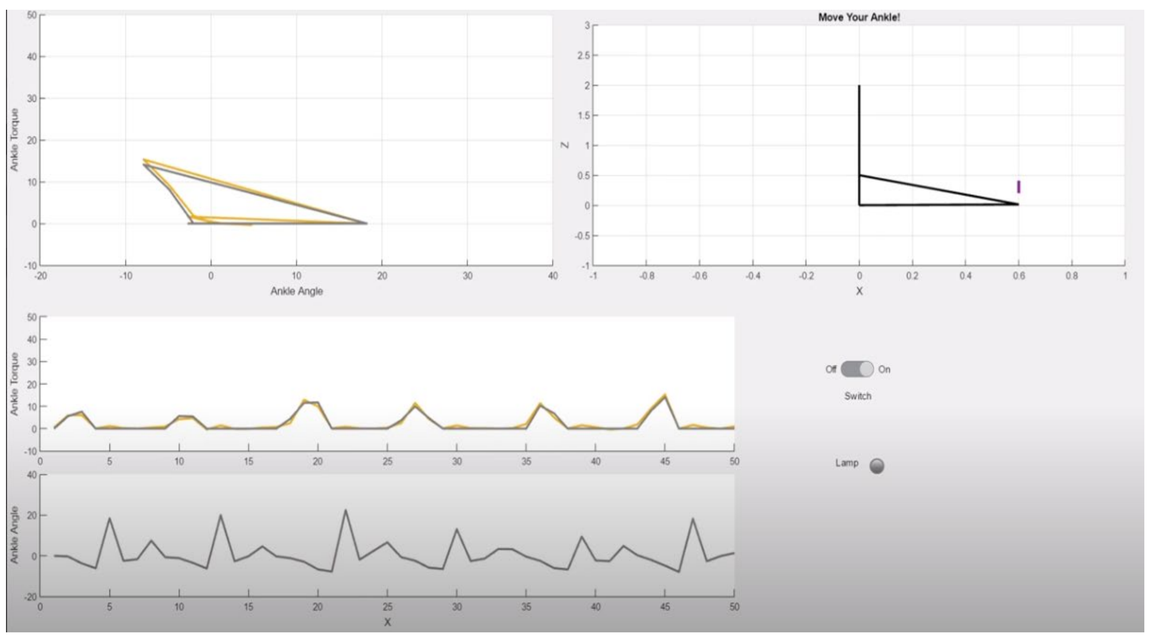

Fig.2 Initial GUI : Upper (from left to right) – Ankle angle torque curve, foot animation. Below(from top to bottom) – Time based ankle torque curve and time-based ankle angle curve.

B. Choose the parameter

- We chose the parameter that most benefits to the user and we conducted a "preference" test.
- Using an eye-tracking device while walking, the user saw all the initial concept of the GUI at once and we monitored where the user stared.
- A user's gaze indicates their interest.
- The metric used to measure this will be the percentage time of staring.
- A total of four subjects participated in the test to choose the preferred candidate GUI.

Results

A. Final concept of the visual guidance GUI

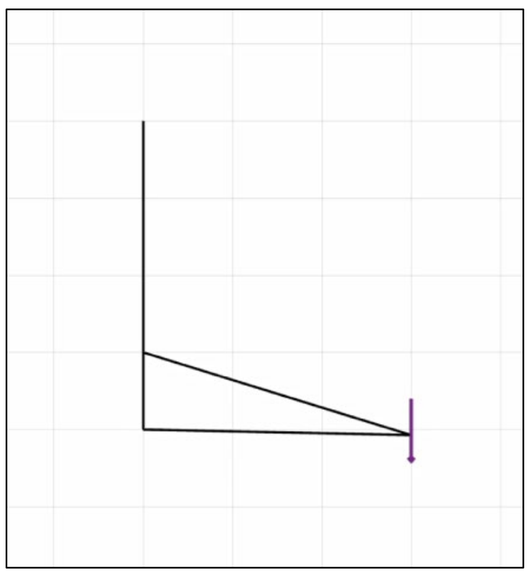

Fig.3 Final concept of the GUI

- The results showed that **the ankle animation GUI (Fig 2. Right) was the preferred.**
- It was also reported to be the easiest to physically see for subjects.
- The final concept of the GUI is the foot animation that displays the participant's foot movement in the sagittal plane. The GUI shows an arrow to instruct user's foot movement direction with magnitude based on the tracking error.

B. Future work

- We plan to conduct the human subject experiments to test feasibility of the effects of the visual guidance system.
- After initially testing with three different R-AFO conditions, we will select two conditions, which presented the minimum (best) and maximum (works) metabolic cost, respectively.
- Then, we will examine the effect of the visual guidance on the participant's R-AFO use by measuring the metabolic cost change after guidance.

References

[1] Huo, W. et.al., IEEE systems Journal, 10(3), 1068-1081.
[2] Ikemoto, S., IEEE robotics & automation magazine, 19(4), 24-35.
[3] Kao, P. C. et.al., Gait & posture, 37(1), 113-120.
[4] Paas, F., Educational Psychology Review, 24(1), 27-45.
[5] Kim, M.., Journal of NeuroEngineering and Rehabilitation, 12(1), 43
[6] Kim, S. H., Experimental brain research, 202(4), 809-824.