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Writely: Force Feedback for Non-Dominant Hand Writing Training

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***Abstract*— We propose Writely, a haptic force feedback system that uses Haply force feedback device for training non-dominant hand writing. In this work we have developed two different force feedback modalities, Guidance and Anti-Guidance. Through a preliminary exploration, our early results shed light on the potential of Anti-Guidance and a low cost, planar, haptic device specifically for writing motor skill training.**

I. Introduction

Haptic force feedback has been used for training purposes, such as improving children's hand writing skills [1] and rehabilitating extremities of stroke patients [2], using different feedback modalities which include Guidance, Partial-Guidance, and Disturbance. While these works show promise for the use of force feedback in motor skill training, we aim to address a few key gaps. First, we intend to explore how force feedback can aid mature and unimpaired adults in improving their writing motor skills in their non-dominant hand. Second, while Anti-Guidance has been used in previous works [3], to our knowledge it has not been used as a method for writing training. Finally, many research works that focus on motor skill training use relatively expensive haptic devices which work in more than 2DOF, such as the Phantom devices[1]. Therefore, through a Haply[2], which benefits from a low cost and planar 2DOF form factor, we aim to make the writing training more natural and accessible.

Fig. 1: Writely interface (left); a user practicing with the Haply using a modified pen-like end effector (right)

II. Writely Application

Our application[3] was built using Processing and Fisica (Fig 1). Writing can be done using Guidance (G), Anti-Guidance (AG), and No Force (NF) Feedback. Writely creates the letters as a series of line segments which allows for the calculation to the closest point on a letter from the end effector's position. The forces rendered are calculated based on the distance between these points. For both G and AG, the forces are applied towards or away from the central line of the letter respectively (Fig 2). In G, a guiding force is provided throughout the writing task, which gently brings the user back to the central line of the letter if needed. In contrast, AG forces actively push the user off the defined path which requires much more effort to remain on the central path of the letter.

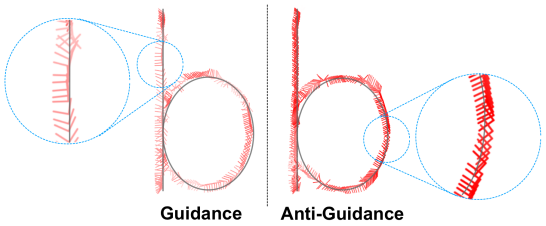

Fig. 2: Forces during G and AG; Arrow and saturation conveys the direction and amount of applied force respectively.

III. Preliminary Results and Discussion

A preliminary experimentation spanning 7 days (2 sessions a day, 4 repetitions x 7 letters = 28 instances a session) was conducted where we separately administered one of the 3 feedback conditions to users. Writely currently consists of 7 complexity classified letters [1] (b, e, l, n, o, r, s). We collected NF writing data from all users at the beginning, middle, and end of the experimentation for evaluation. Our early results suggest that AG, using Haply and Writely, provides a beneficial environment for non-dominant hand writing training; while time to write a letter did not change, acceleration and jerk both provided significant changes which resulted in improved visual quality (smoothness and consistency). Furthermore, users had positive feedback regarding the haptic conditions themselves and the use of Haply and Writely. Further work in this space will utilize more rigorous and complete experimental methods. This includes a broader range of force feedback modalities, a quantitative metric for writing quality, and a full user study incorporating sentences to properly assess the use of AG and the Haply.

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[1]https://www.3dsystems.com/haptics, [2]https://www.haply.co/, [3]built as per course requirements of CanHaptics 501 (https://wiki.canhaptics.ca)

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