Wearable Technology and Mobile Healthcare (WTMH) Lab

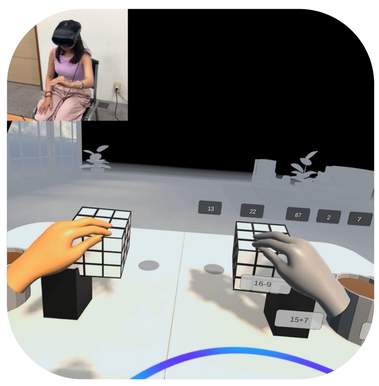
Virtual Reality Mirror Therapy with Focus Obejective Attention

Advisor: Hsiu-Yun Hsu, Che-Wei Lin
Author: Ai-Ting Huang

Gaze-Guided Virtual Reality Mirror Therapy that Enhances Cortical Activation and Network Coherence for Stroke Rehabilitation

VRMT
FOA

Introduction



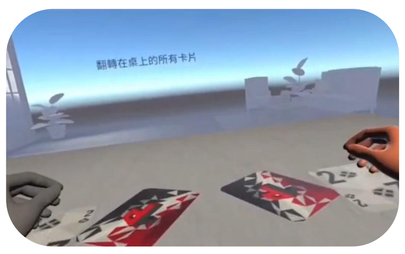
Dual-task design, stimulates multiple brain regions and boosts motivation.

Cognitive tasks guide patients to actively focus on the affected side.

Eye tracking system, the attention of the patient could be evaluated.

Our system **locks patients' attention** and **tracks it in real time,** allowing us to **ensure focus** and investigate **whether prolonged gaze contributes to better rehabilitation outcomes** and neuroplastic changes.

Design and Comparison

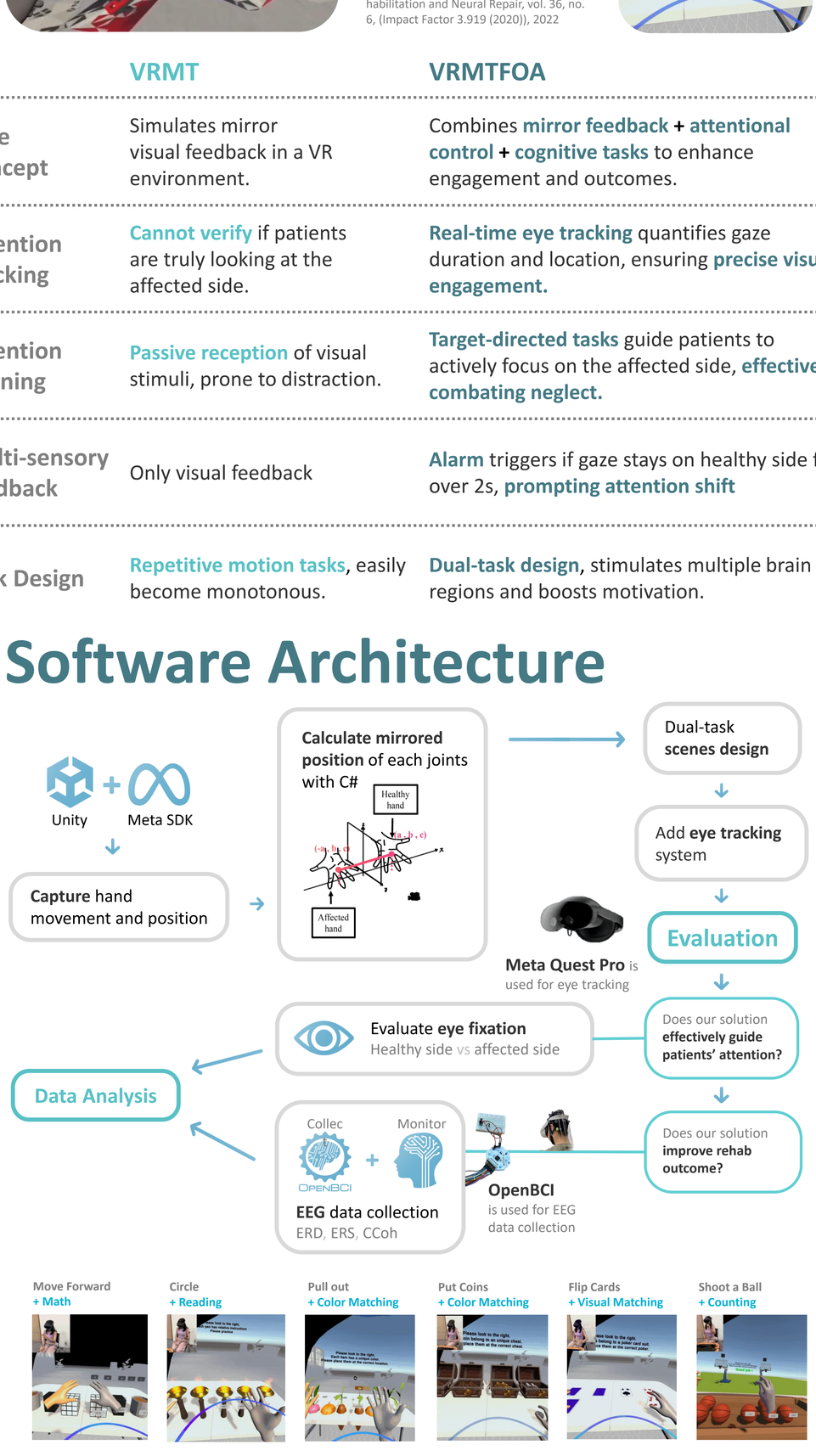


Previous work (published) of our research team:

[1]Hsiu-Yun Hsu, Li-Chieh Kuo, Yu-Ching Lin, Fong-Chin Su, Tai-Hua Yang, and Che-Wei Lin*, "Effects of a Virtual Reality–Based Mirror Therapy Program on Improving Sensorimotor Function of Hands in Chronic Stroke Patients: A Randomized Controlled Trial," Neurorehabilitation and Neural Repair, vol. 36, no. 6, (Impact Factor 3.919 (2020)), 2022

	VRMT	VRMTFOA
Core Concept	Simulates mirror visual feedback in a VR environment.	Combines **mirror feedback** + **attentional control** + **cognitive tasks** to enhance engagement and outcomes.
Attention Tracking	**Cannot verify** if patients are truly looking at the affected side.	**Real-time eye tracking** quantifies gaze duration and location, ensuring **precise visual engagement.**
Attention Training	**Passive reception** of visual stimuli, prone to distraction.	**Target-directed tasks** guide patients to actively focus on the affected side, **effectively combating neglect.**
Multi-sensory feedback	Only visual feedback	**Alarm** triggers if gaze stays on healthy side for over 2s, **prompting attention shift**
Task Design	**Repetitive motion tasks**, easily become monotonous.	**Dual-task design**, stimulates multiple brain regions and boosts motivation.

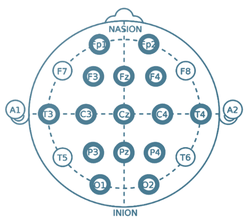
Software Architecture



Evaluation

To evaluate how attention is guided and how shifts in attention affect outcomes, we use **EEG indicators** and **eye tracking** to assess brain activation, and compare the results with traditional VRMT.

20 young healthy participants were recruited



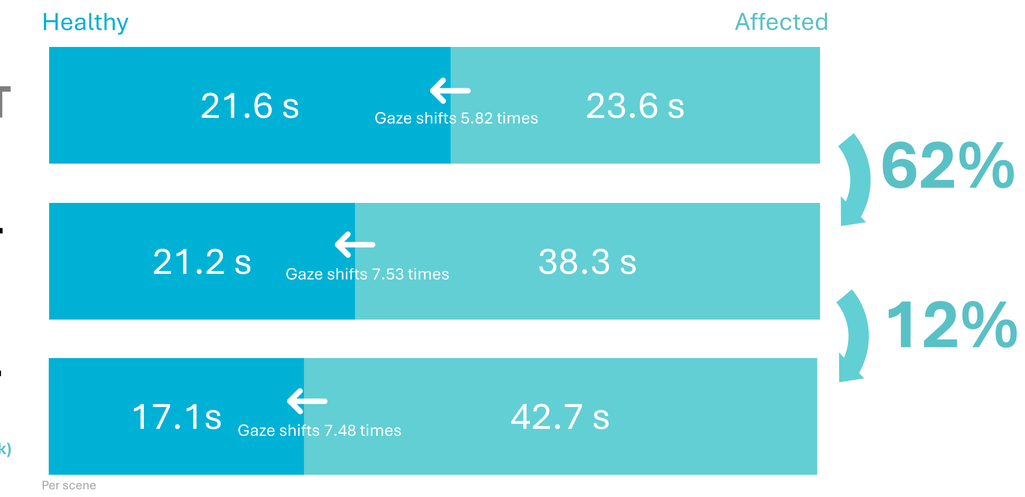
AB-BA crossover trial
Each subject would receive **3 different modes** of rehabilitation

15 channels were collected, including
Fp1, Fp2, F3, Fz, F4, C3, Cz, C4, P3, Pz, P4, O1, and O2.

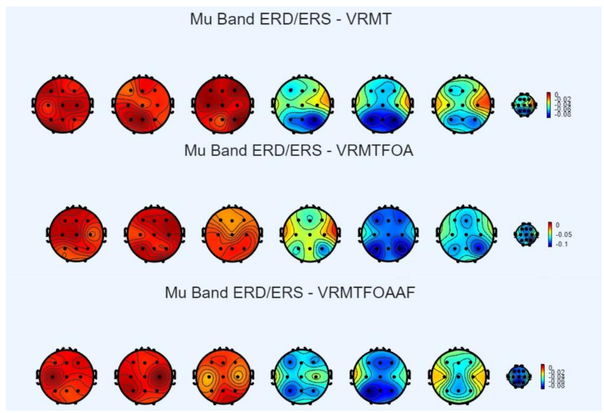
Time	1	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	1.5
State	R	A	R	A	R	A	R	A	R	A	R	A	R
G1	Baseline	VRMT (6 scenes)											
G2	Baseline	VRMTFOA(6 scenes)											
G3	Baseline	VRMTFOAAF(6 scenes)											

Results

Eye Tracking



ERD / ERS



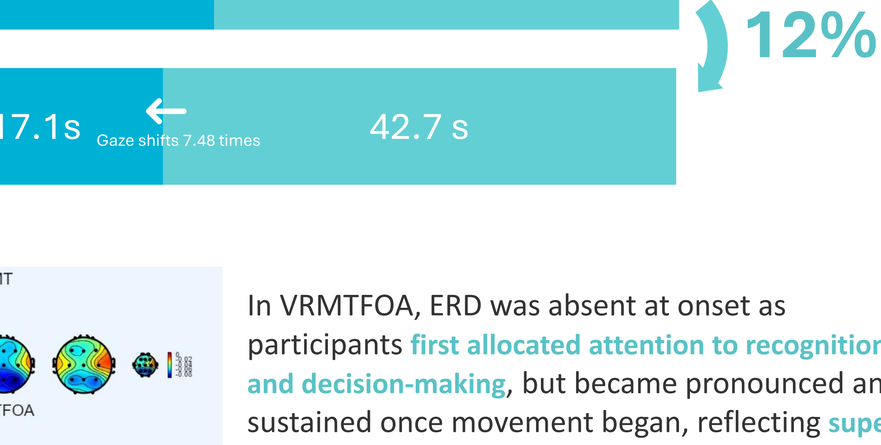
In VRMTFOA, ERD was absent at onset as participants **first allocated attention to recognition and decision-making**, but became pronounced and sustained once movement began, reflecting **superior motor cortical activation compared to VRMT.**

In VRMTFOAAF, corrective effects emerged ~2 s after execution, **reducing cognitive load** and producing **slightly lower ERD amplitude**, yet with a more uniform and **stable distribution**.

Coherence difference

VRMT induced weak and transient connectivity, VRMTFOA enhanced coherence during movement with residual effects, and **VRMTFOAAF further sustained broader and more durable neural connectivity during recovery**.

VRMT
VRMTFOA
VRMTFOAAF



Conclusion

Integrating attentional guidance **(VRMTFOA)** and auditory feedback **(VRMTFOAAF)** into VR mirror therapy **enhances engagement and neural activation.** Although tested only in a small healthy cohort, **future work will validate these findings in stroke patients** and extend to tele-rehabilitation and low-cost home systems, highlighting its promise for intelligent, multimodal neurorehabilitation.