IDVR' 24 Midterm Project Report
Group 2 - EMS Mario

Member: 黃永恩 、顏紹同、王婉怡、施孟廷

Design motivation:

Super Mario is a beloved game across generations. As virtual reality (VR) has become a major gaming platform, many developers have attempted to recreate this classic game in VR. Leveraging VR's immersive features, Super Mario in VR becomes highly interactive compared to the traditional screen version, allowing players to control Mario in first-person view and interact with environment objects (e.g., mystery blocks or enemies).
However, due to limited feedback, especially haptic sensations, users may experience motion sickness while controlling Mario. To address this, we adapted the Seated-Walking-in-Place (Seated-WIP) technique and Electrical Muscle Stimulation (EMS) to offer a suitable control method and feedback. These techniques allow users to control Mario using real-world walking motions and provide haptic feedback to reduce motion sickness.

Usage method:

In this project, we designed and implemented 5 tasks. Each task is related to the one required task.

Task 1: Walk & Run & Stair

In the Walk state, we use alternating steps between the left foot toe and right foot toe.
For the Run state, we have users swing their hand or controller to generate velocity, which is then adapted to enhance the user's current movement speed. Additionally, backward movement is implemented through alternating steps between the right heel and left heel. Finally, for stair objects, users can smoothly climb from the bottom during the movement of Seated-WIP.

Task 2: Jump

In the Jump state, we use Mario's classic jump posture. Specifically, if the right foot is raised while the left foot stays on the ground (or vice versa), the user will jump forward. During this state, EMS continuously stimulates the leg muscles to provide haptic feedback, simulating a real jump. In Mario VR, the Jump state is used to hit mystery boxes to retrieve items, stomp on monsters (task 5) to defeat them, and jump onto different levels of bricks.

Task 3: Uphill & Downhill

For Uphill and Downhill movement, we use EMS to raise both foot toes and both foot heels, respectively. Raising the toes makes the Seated-WIP more challenging to step forward, while

raising the heels makes it easier. This adjustment allows the user to experience more difficulty moving forward uphill and less effort moving backward downhill.

Task 4: Teleport

For the Teleport state, we implemented the classic Mario pipe to simulate teleportation. Specifically, the user needs to jump onto the top of the pipe, lift both feet momentarily, and then ground their feet to trigger the teleport to another pipe.

Task 5: Switch Lane & Fight the monster and boss

In task 5, we aim to keep the user in a specific lane to maximize the Mario VR gaming experience using Seated-WIP and EMS. We implemented head tilting to allow lane-switching. Additionally, we added enemies—both monsters and a boss—on the lane and at the end. For regular enemies, users can either jump on them to defeat them or use items from mystery boxes. For the boss, users need to dodge missiles and can use a gun to shoot at the boss.

Advantages:

Our Super Mario VR not only implements the five assigned locomotion tasks and applies haptic feedback effectively but also creates an interactive gaming experience using Seated-WIP and EMS. Additionally, to enhance VR immersion and simulate a realistic walking experience, we use two sets of EMS devices to make Seated-WIP more challenging and realistic during specific movements, such as stepping on hills or jumping.

Reflections & Disadvantages:

The reflections and disadvantages of our project mainly fall into two areas: 1) The integration of EMS and Seated-WIP is not as smooth as expected. For example, EMS should stimulate the muscle only at the moment of the jump, not throughout the entire process. Additionally, the intensity of EMS should be based on the Seated-WIP threshold to create a more realistic experience, such as stepping on hills. 2) Although our Mario VR is fairly straightforward, we did not develop a complete tutorial for the game, which should be a focus for future work.

Work distribution:

- 黃永恩: Use EMS to provide haptic feedback during actions such as jumping, walking uphill and downhill, stepping on hills, and climbing stairs; organize and integrate all scripts.
- 顏紹同: Create animations and mechanisms for enemies (monsters and the boss), teleport pipes, and other scene objects.
- 王婉怡: Construct the scene elements, including uphill and downhill paths, various brick levels, and coordinate the overall scene style.
- 施孟廷: Use Seated-WIP to control Mario's movements, including forward and backward running, teleportation, and jumping.

Video link:

https://youtu.be/vRl3PtsoIu4

Unity project link:

https://drive.google.com/file/d/11X4ioelfF-pqmztf3fJfh9L2beoHijzy/view?usp=sharing