PRG3014 UI/UX Design

Final Assessment (Project-based)

UX-6-1: Adaptive Comfort System in Virtual Reality (ACSVR) for Motion Sickness User

Deadline: 4 August 2024

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Project Proposal

Problem

Virtual Reality, with its extensive growth and immersive inclusion in human life, has led to health-related issues, including but not limited to feelings of nausea, vomiting, dizziness, and cold sweats. These problems introduce a well-known side effect termed as motion sickness in VR users.

Solution

1. **People:**

Personalized Comfort Profiles: Users can create personalized comfort profiles within the system**, specifying their tolerance levels for motion sickness symptoms such as movement speed, field of view changes, and visual effects intensity / detect early signs of motion sickness** to tailor the VR experience accordingly.

2. **Activities:**

Progressive Exposure Therapy: The solution incorporates **progressive exposure therapy techniques**, gradually exposing users to more intense VR experiences over time. This activity **aims to lessen users' sensitiveness to motion sickness symptoms and build tolerance and resilience**.

3. **Contexts:**

Context-Aware Environment Adjustments: **The system dynamically adjusts the VR environment based on the user's context**, such as the type of VR experience being used, the user's physical environment, and their current physiological state. For example, if a user is starting to show signs of discomfort, **the system may slow down movement speed or reduce visual effects intensity to mitigate motion sickness symptoms.**

4. **Technologies:**

Physiological Sensor Integration and Adaptive Environment Algorithms: **Adaptive Comfort System for Virtual Reality** (ACSVR) incorporates physiological sensors, such as heart rate monitors and eye-tracking devices **to monitor users' physiological responses and detect motion sickness symptoms in real-time.** The system utilizes adaptive algorithms to analyze this data and dynamically adjust VR environment parameters. These algorithms ensure that the VR experience is personalized to each user's comfort levels, effectively minimizing motion sickness symptoms.

5. **Human-Centred:**

User Feedback Loop: **Emphasizing user experience**, the VR system implements a continuous feedback loop. Through user testing and feedback mechanisms, **developers gather insights into individual experiences with motion sickness.** This human-centred approach allows for iterative improvements based on real-world user data, ensuring that the VR experience prioritizes user comfort and satisfaction.

6. **Design:**

Using transition methods when moving in VR: One of the main issues causing motion sickness is locomotion in VR so we can use transition methods rather than moving in VR, teleporting from one location to another. Another method that we can implement is vignetting. Vignetting involves dynamically limiting the user's field of view, particularly during rapid movement in the VR environment.

Justification

After conducted PACT analysis to figure out solutions, we have decided to implement an Adaptive Comfort System for Virtual Reality (ACSVR) in terms of technology to help reduce motion sickness for VR users by using physiological sensors and adaptive algorithms. By utilizing tools like heart rate monitors and eye-tracking devices, the ACSVR can track how users are physically responding in real-time. This monitoring helps detect early signs of motion sickness, allowing for quick actions to reduce discomfort.

Moreover, the adaptive algorithms used in ACSVR processes the physiological data gathered from users. These algorithms adjust different aspects of the VR environment in real-time based on the detected symptoms, ensuring a comfortable experience for each user. By customizing the VR environment to fit individual comfort levels, the ACSVR system significantly reduces the chances of motion sickness, enhancing the overall user experience.

By integrating physiological sensors with adaptive environment algorithms, the system not only detects but also actively reduces motion sickness symptoms. This makes it a thorough and effective solution for minimizing motion sickness in VR.

Case Study

Exergaming With Beat Saber: An Investigation of Virtual Reality Aftereffects

Application/Game: Beat Saber

Hypothesis: VR causes motion sickness to its user.

Research:

Beat Saber was well tolerated, as there were no dropouts due to sickness. For most participants, any immediate aftereffects were short-lived and returned to baseline levels after 40 min of exiting VR. Although at a group level, participants' sickness levels returned to baseline 40 min after VR exposure, approximately 14% of the participants still reported high levels of sickness in the late test period after playing 50 min of Beat Saber. They also showed that the participants who experienced a high level of sickness after a short exposure were almost certain to experience a high level of symptoms after a longer exposure.

Insights:

The issue of motion sickness, although not being critical in most situations, it still appears in some individuals and especially people who already seem susceptible to short exposures of Virtual Reality usage. Motion sickness is still proven to be an issue because 14% of participants experience this problem and could worsen.

Milestone 1 - Research and Analysis

Problem and Solution Overview

Problem

Virtual Reality (VR) has become an integral part of modern life, offering immersive experiences across various domains, from gaming to education. However, alongside its widespread adoption, VR technology brings forth significant health-related challenges, prominently among them, motion sickness. Users often report discomforting sensations such as nausea, vomiting, dizziness, and cold sweats, collectively referred to as motion sickness (Chattha et al., 2020). This phenomenon poses a notable hindrance to the enjoyment and usability of VR systems, potentially deterring users from engaging with the technology altogether (Zhang, 2020).

Solution

PACT analysis was conducted to figure out the solutions for mentioned problem. Table 1.1 shows the solutions.

Table 1.1: Solutions

<table>
<tr><td>People</td><td rowspan="2">Users can create personalized comfort profiles within the VR system, specifying their tolerance levels for motion sickness symptoms such as in-game movement speed, field of view changes, and visual effects intensity. The Adaptive Comfort System for Virtual Reality (ACSVR) uses built-in physiological sensors like heart rate monitors and eye-tracking feature to monitor users' responses and detect motion sickness in real-time. The algorithms analyze this data and adjust VR environment parameters, ensuring the VR gaming experience is personalized to each user's comfort levels, effectively minimizing motion sickness symptoms.</td></tr>
<tr><td>Technologies</td></tr>
<tr><td>Activities</td><td rowspan="2">The solution uses progressive exposure therapy to gradually expose users to more intense VR gaming experiences, reducing sensitivity to motion sickness and building tolerance. Additionally, the system dynamically adjusts the VR gaming environment based on the user's context, such as the type of game, physical environment, and physiological state.</td></tr>
<tr><td>Contexts</td></tr>
</table>

Human-Centred	User Feedback Loop: **Emphasizing user experience**, the VR system implements a continuous feedback loop. Through user testing and feedback mechanisms, **developers gather insights into individual experiences with motion sickness.** This human-centred approach allows for iterative improvements based on real-world user data, ensuring that the VR experience prioritizes user comfort and satisfaction.
Design	Using transition methods when moving in VR: One of the main issues causing motion sickness is locomotion in VR so we can use **transition methods** rather than moving in VR, teleporting from one location to another. Another method that we can implement is **vignetting**. Vignetting involves dynamically **limiting the user's field of view**, particularly during rapid movement in the VR environment.

Justification

After conducted PACT analysis to figure out solutions, we have decided to implement an Adaptive Comfort System for Virtual Reality (ACSVR) in terms of people and technology to help reduce motion sickness for VR users by using physiological sensors and adaptive algorithms. By utilizing tools like heart rate monitors and eye-tracking feature, the ACSVR can track how users are physically responding in real-time. This monitoring helps detect early signs of motion sickness, allowing for quick actions to reduce discomfort.

Moreover, the adaptive algorithms used in ACSVR processes the physiological data gathered from users. These algorithms adjust different aspects of the VR environment in real-time based on the detected symptoms, ensuring a comfortable experience for each user. Besides that, users can create their own personalized comfort profiles. By customizing the VR environment to fit individual comfort levels, the ACSVR system significantly reduces the chances of motion sickness, enhancing the overall user experience.

By integrating physiological sensors with adaptive environment algorithms, the system not only detects but also actively reduces motion sickness symptoms. This makes it a thorough and effective solution for minimizing motion sickness in VR.

User Research

User Research Plan

Research Method:

After conducted the PACT analysis to confirm the problem statement and solutions, we then utilized Google Forms as our research method to gather insights in understanding users. Google Forms allowed us to gather data from a wide range of participants by asking them specific questions related to their VR experiences and motion sickness.

The survey comprises a mix of closed-ended and scaled questions, facilitating the collection of standardized, quantitative data. This structured format enables us to systematically gather information on participants' touchpoints, pain points, requirements and so on.

Participants:

The Google Form was distributed to our own friend, family members and students from the School of Engineering and Technology in Sunway University. This allows us to have different participants from various age groups, at the same time targeted individuals who are more likely experienced VR before.

Measure:

The Google Forms survey consisted of three sections: Personal Information, Virtual Reality (VR) Experience, and Motion Sickness in Virtual Reality (VR).

In the "Personal Information" section, participants were asked about their name, age, gender, and occupation.

The "VR Experience" section focused on questions related to participants' previous experience with VR, their first impressions in VR, usage frequency, content preferences and so on. This section allows us to have general understanding on how our participants started to engage with VR experiences and what contents they usually engage with.

Lastly, the "Motion Sickness in VR" section aimed to understand participants' VR experiences with motion sickness, including triggers, severity, coping mechanisms, and suggestions for improvement. This section not only allowed us to gain more insights about the existence of motion sickness, but also reveals the pain points or requirements of the VR users.

All the questions are useful enough to help us understanding our users, providing significant information in creating the user journey map, which includes before, during, and after experience with VR.

User Research Findings

By using Google Forms, we were able to collect quantitative data that enabled us to gain a comprehensive understanding of the challenges faced by motion sickness users in VR and informed the development of the Adaptive Comfort System in Virtual Reality (ACSVR).

We have received 19 responses in total. 14 of participants have experiences in VR. Most of the participants (78.6%) are in the age range 18-25. Interestingly, half of the participants had their first VR experience by trying a demo at a store or event. In terms of usage frequency, 42.9% of them use VR monthly, 42.9% rarely, and 14.3% weekly. Besides that, 92.9% of the participants use VR to play games.

Regarding motion sickness, 92.9% of them claimed that they experienced motion sickness. Rapid movement, environmental changes, and field of view (FOV) are the top 3 factors that triggered motion sickness. 10 of the participants experienced moderate to severe motion sickness, and most of them chose to take breaks during VR sessions to cope with the motion sickness. Notably, 11 participants admitted that motion sickness affects their enjoyment in VR moderately to severely.

User Journey Map

A user journey map is a visual or graphical representation that illustrates the process a user goes through when interacting with a product or service. It captures the user's experiences, emotions, and touchpoints from the initial encounter to the completion of their goal, providing insights into their needs, expectations, and pain points. The map helps us in understanding and improving the overall user experience by identifying opportunities for enhancement and highlighting areas that require attention.

Based on the information above and the user research that we conducted, we have deduced our own user journey map for the project (or refer Appendix 2):

First Phase: Obtaining a VR device or an Opportunity to try VR Technology

The journey begins with a user becoming aware of VR technology through advertisements, social media, or recommendations from friends and family. They might research different VR devices, reading reviews and comparing features on e-commerce platforms and tech blogs. The excitement and anticipation are high during this phase. Once they obtained the VR device (whether trying demo in a shop or using it for the first time at home), the user begins the setup process. They refer to the quick start guide and follow step-by-step tutorials available online, such as video guides from the manufacturer or tech influencers on platforms like YouTube.

Second Phase: Starting to Experience VR

With the setup complete, the user launches VR applications and begins exploring different types of VR content. They navigate through virtual environments using the headset and controllers, trying out various experiences such as virtual travel, gaming, or creative design tools. During this initial exploration, the user may start to feel symptoms of motion sickness, such as dizziness or nausea, which can cause discomfort and disappointment. This realization that motion sickness could limit their ability to enjoy VR fully might lead to frustration and concern.

Third Phase: Starting to Have Motion Sickness

As the user spends more time in VR, they begin to notice the existence of motion sickness. Symptoms such as dizziness, nausea, and headaches become more pronounced during specific types of VR experiences, particularly those involving rapid movement or significant environmental changes. The severity of these symptoms can vary; some users might experience mild discomfort that might fades, while others might suffer from severe nausea that lasts for a while.

Fourth Phase: Finding Solutions to Cope or Reduce Motion Sickness

Determined to find a solution to their motion sickness, the user might try different ways to reduce the discomfort. They may seek solutions online, through customer support, activating and adjusting available comfort settings or just taking breaks. The interruptions in their VR experience to adjust settings and find relief add to the challenge.

Throughout the journey, the user experiences a range of emotions. They start with high enthusiasm and excitement during the first phase when they are obtaining a VR device or an opportunity to try VR technology. The onset of motion sickness starting from second phase can lead to significant discomfort and disappointment. However, as the user figured out solutions to reduce motion sickness, their hopefulness and satisfaction increase.

Persona, User Stories and Acceptance Criteria

Persona

Personas are concrete representations of the different types of people that the system or service is being designed for. Alan Cooper introduced the idea of personas in the late 1990s (Cooper, 1999) and have gained rapid acceptance as a way of capturing knowledge about the people that the system or service is targeted at. In short, the development of persona helps us in identifying the various behavior patterns that different users may demonstrate. As any new system is likely to be used by different types of people, therefore it is important to develop several different personas. With this goal in mind, we had developed three distinct personas which is shown in Table 1.2 (or refer Appendix 3).

Table 1.2: Personas

	Persona 1: David Kim	Persona 2: Sarah Lopez	Persona 3: John Carson
Age	37	22	30
Marital Status	Married; Dink	Single; Live alone	Divorced: Live alone
Background	David is a 37-year-old teacher working in a secondary school. He has been married for five years to his colleague, Maria. They enjoy a comfortable lifestyle as DINKs (Dual Income, No Kids), allowing them the freedom to pursue their interests and hobbies together. Therefore, Alex is always eager to explore new	Sarah Lopez is a diligent student pursuing her undergraduate degree in Computer Science. Her main responsibilities include attending lectures, completing assignments, and conducting research for projects. She is tech-savvy, proficient in using various software tools for coding and design tasks. Apart from her studies, she is also a part-time tutor, helping high school	John, a cashier with a high school diploma, lives alone after his marriage ended. After his marriage ended three years ago, he found solace in virtual reality (VR) gaming, which quickly became his main source of joy. Living alone in a modest apartment, Jon spends hours everyday immersed in VR worlds after work, escaping the loneliness and stress of his daily life.

	entertainments to spend quality time with Maria.	students with their math and science subjects. She actively participates in community service initiatives, volunteering at local shelters during weekends.	
Emotion and Attitude	David approaches life with optimism and a spirit of "work hard, play hard," balancing his dedication to his career with a commitment to enjoying life to the fullest.	Sarah Lopez is enthusiastic about technology, using various software tools effectively in her studies as a diligent undergraduate student in Computer Science. She actively engages in lectures, assignments, and research projects, demonstrating a positive attitude towards her academic pursuits.	Jon is passionate about gaming, immersing himself in VR worlds to escape the sadness and loneliness of his daily life. He values the freedom and excitement that VR gaming provides, finding solace in its immersive experiences. In gaming, particularly as he unlocks achievements, Jon finds a sense of personal worth and accomplishment that he struggles to find elsewhere.
Personal Trait	Adaptable; Values relationships	Enthusiastic; Diligent; Compassionate	Persistent and dedicated gamer; Introvert
Situation	David and his wife have always been committed to exploring new things. However, recently, his wife was dissatisfied with the lack of "us time" due to his busy work schedule. Therefore, David decided	Sarah is passionate about gaming and VR technology. She is participating in a semester-long VR development course where she and her classmates are tasked with creating an immersive VR	Jon, already proficient in VR gaming, has been given the opportunity to participate in a highly competitive VR gaming tournament. However, he faces a challenge as he typically reduces his

	not to deal with work matters after work and focus on spending quality time with Maria. Therefore, he began to explore new entertainments that he can experience with Maria, which is playing VR together.	game. The project requires long hours of VR testing and coding.	motion sickness by taking frequent breaks during gameplay.
Scenario	David decided to try out virtual reality (VR) gaming with his wife to spend more quality time together. However, their excitement turned into discomfort as they both experience motion sickness during their first session. Determined to overcome this problem, David found Adaptive Comfort System for Virtual Reality (ACSVR), which successfully reduced their discomfort with the real-time suggestions and adjustment. Despite they still need time to get used to the immersive VR world, David feels relieved	She recently purchased a VR headset to both play immersive games and learn VR development. However, she often feels motion sick after short VR sessions, which limits her ability to enjoy and work with VR. After hearing about the Adaptive Comfort System for Virtual Reality (ACSVR) from a friend, Sarah decides to try it out. She installs the system, noticing a significant reduction in motion sickness. With the ACSVF system adjusting the VR environment in real-time, Sarah can enjoy longer gaming sessions and focus on her VR development	Determined to maximize his training efforts, Jon decides to invest his savings in the Adaptive Comfort System for Virtual Reality (ACSVR), despite initial hesitation. As he sets up the ACSVR system and begins playing his favourite VR games, he notices a remarkable difference in his comfort level. The ACSVR's real-time adjustments provide Jon with a seamless gaming experience, allowing him to play for extended periods with minimal motion sickness. With this newfound ability to immerse himself fully in VR without interruption,

	that they overcame this relationship crisis.	projects without discomfort. Excited about the improvement, she shares her positive experience with her classmates and provides feedback to the developers to help refine the system.	his performance improves significantly.

User Stories and Acceptance Criteria

Based on the three personas we developed, user stories and acceptance criteria are created as well to guide the development process. A user story and acceptance criteria are key components in Agile development. They help us in understanding what needs to be built and ensure that the final product meets the users' needs. Table 1.3, 1.4 and 1.5 show their respective user stories and acceptance criteria:

Table 1.3: User Story and Acceptance Criteria of Persona 1 - David Kim

Title: Reducing Motion Sickness	Priority: Low	Estimate: 2 months
As a husband who suggested to play VR in order to strengthen relationship with my wife**,** **I want to** have immersive VR experience with minimal motion sickness, **So that I can** obtain quality time spent with my wife.		
Given VR is a new entertainment for us, **When** using the VR, **Then** the system should consistently monitor our condition and adjust settings to reduce our motion sickness.		

Table 1.4: User Story and Acceptance Criteria of Persona 2 - Sarah Lopez

Title: Ensure Comfort During VR Development	Priority: Moderate	Estimate: 2 months
As a computer science student studying VR Development, **I want to** ensure a comfortable and productive environment during my VR development sessions,		

So that I can effectively work on my VR projects without any discomfort.
Given VR development requires long hours of testing and iteration, **When** using the system, **Then** I should be able to focus on my work without experiencing discomfort, leading to more efficient development cycles.

Table 1.5: User Story and Acceptance Criteria of Persona 3 - John Carson

Title: Reduce Motion Sickness	Priority: High	Estimate: 2 months
As a dedicated VR gamer**,** **I want to** effectively manage my motion sickness during extended gameplay sessions, **So that I can** train without interruption and perform at my best in the VR gaming tournament.		
Given I am playing VR for extended periods, **When** the system detects signs of motion sickness, **Then** I receive suggestions for adjustments to reduce discomfort.		

Summary of Milestone 1

Virtual Reality (VR) has become an integral part of modern life, providing immersive experiences across various domains, but it also brings significant health-related challenges, notably motion sickness. This project aimed to address the motion sickness issue through the development of Adaptive Comfort System for Virtual Reality (ACSVR).

A PACT analysis was conducted to identify solutions to motion sickness in VR. The results led to the creation of the ACSVR, which employs built-in physiological sensors like heart rate monitors and eye-tracking features to monitor users' responses in real-time. Adaptive algorithms then analyse this data and adjust VR environment parameters to match each user's comfort levels, effectively minimizing motion sickness symptoms.

User research, carried out through Google Forms, gathered data from a diverse participant pool, providing insights into their VR experiences and the factors triggering motion sickness. The survey results revealed that a significant majority of users experienced motion sickness, highlighting the need for a solution like ACSVR. This information is important in developing detailed user journey maps, personas, and user stories, ensuring the system addresses the real needs and pain points of VR users.

This initial phase of research and analysis has established a strong foundation for the development of a system that significantly improves the usability and enjoyment of VR by addressing the prevalent issue of motion sickness.

Milestone 2 - Ideation and Conceptualization

Task Analysis

Task analysis involves breaking down a structured set of activities that are necessary for an agent to achieve a specific goal using a particular technology. This method helps us to understand and improve the design process by identifying and detailing each step involved.

The persona we have chosen for task analysis is Sarah Lopez. She is a computer science student studying VR Development, therefore a comfortable experience during VR development sessions is very important so that she can effectively work on her VR projects without any discomfort. In summary, her goal is to ensure comfort during VR development. With this goal in mind, we have breakdown the task into smaller subtasks and created a layered task diagram as shown in Figure 2.1.

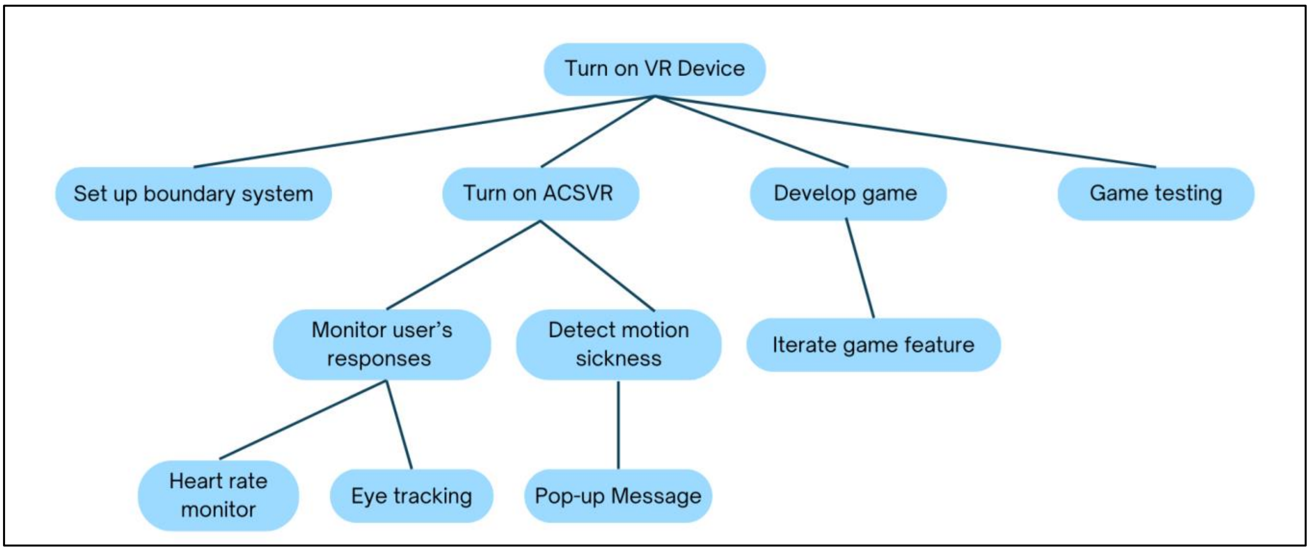


Figure 2.1: Task Analysis for Sarah Lopez

Task analysis is not just about understanding the procedures involved but also about knowing what can be accomplished within a particular domain.

In the context of the Adaptive Comfort System for Virtual Reality (ACSVR) project, the task analysis for Sarah involves several key steps to reduce motion sickness, ensuring comfort during VR development:

- Turn on VR Device: The user powers on the VR headset and associated equipment.
- Set Up Boundary System: The user configures the VR play area to ensure safety.

- Turn on ACSVR: The user activates the ACSVR system, adjusting settings and connecting necessary sensors.
- Develop Game: Game developers create and refine VR content, integrating ACSVR features.
- Iterate Game Feature: Developers continuously improve game features to optimize user experience.
- Monitor User's Responses: The system monitors the user's physiological responses using tools like heart rate monitors and eye trackers.
- Detect Motion Sickness: The ACSVR system detects signs of motion sickness through real-time data analysis.
- Pop-up Message: The system may display notifications to inform the user of detected motion sickness and suggestions to reduce it.
- Game Testing: The user continues with her VR development.

This detailed task analysis helps us to better understand the user needs. By understanding both the procedures and the structural knowledge required, we can develop better systems that meet user needs and expectations.

User Flow

The stages or actions a user takes when using an application from the start up to the goal is completed are referred to as user flow (Kathleen, 2021). User flow plays an important role to ensure that the system or application developed meets user needs effectively and efficiently, promising to provide good user experience to the user. By visualizing the user flow, it easier for us to improve user convenience, evaluate the app interface, and explain how the app works (Satyaninggrat et al., 2023). This user flow provides a structured pathway, starting from the initial setup to real-time adjustments during VR use, ensuring that Sarah and other users can maintain their focus and productivity without experiencing motion sickness. By following this user flow, the system helps create an optimal VR development environment that supports both user well-being and performance. Figure 2.2 demonstrates the user flow.

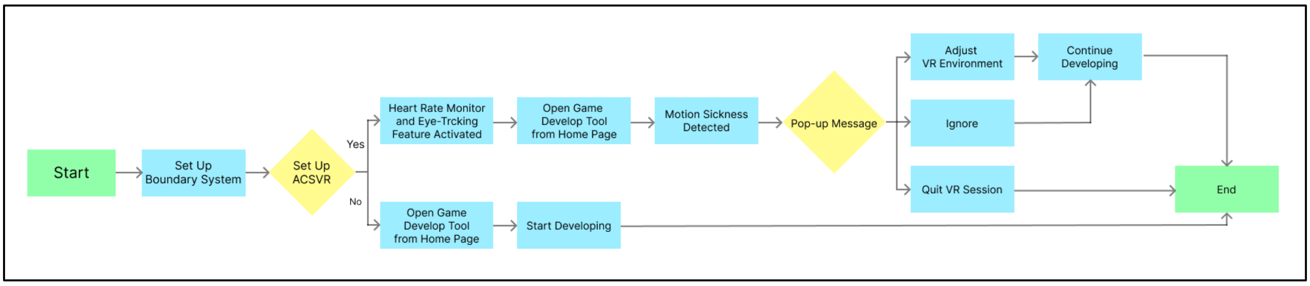


Figure 2.2: User Flow

The user flow for the Adaptive Comfort System in Virtual Reality (ACSVR) for motion sickness users begins with the initial setup. When the user starts the system, they first set up a boundary system. This boundary system is crucial for ensuring the user's physical safety, as it defines a safe area within which they can move, preventing physical collisions that might occur in the real world while they are immersed in the virtual environment.

Next, the system prompts the user to set up the ACSVR. This system is specifically designed to help users who experience motion sickness while using VR. If the user chooses to set up the ACSVR, the system activates key features such as the heart rate monitor and eye-tracking. These features play a critical role in detecting early signs of motion sickness by continuously monitoring the user's physiological responses.

Once the ACSVR setup is complete and the monitoring features are activated, the user proceeds to open the game development tool from the home page. This tool allows the user to begin developing their VR application. During the development process, the system keeps monitoring the user for signs of motion sickness. If motion sickness is detected, a pop-up message is displayed to the user, informing them of the situation and providing several options.

The pop-up message offers three options to the user. First, they can choose to adjust the VR environment based on their preset personalized profile or system default settings. This adjustment can help alleviate the symptoms of motion sickness by altering factors such as the frame rate, field of view, or other environmental settings. Alternatively, the user can choose to ignore the message and continue developing without making any changes. Finally, if the user feels too uncomfortable, they have the option to quit the VR session entirely.

If the user decides to adjust the VR environment, they can then continue developing their application with the new settings in place. This option ensures that the user can proceed in a more comfortable and sustainable manner. On the other hand, if the user ignores the pop-up message, they continue their work without any adjustments. If the user quits the VR session, the process ends, allowing the user to take a break and prevent further discomfort.

If the user chooses not to set up the ACSVR, they bypass the heart rate monitoring and eye-tracking features. Instead, they proceed directly to opening the game development tool from the home page and begin developing their VR application. Without the ACSVR's continuous monitoring for motion sickness, the user won't receive proactive alerts or recommendations to adjust the VR environment. This scenario allows the user to continue working uninterrupted but without the additional layer of comfort and safety provided by the ACSVR system.

Interaction Model

An efficient interaction model is crucial to ensure a seamless, engaging, and enjoyable experience for users in the virtual environment. Interaction model is the point for laying the foundation for a great user experience as it informs the way the product behaves with users and visualizes the interactions between the system and our users. Table 2.1 displays the interaction model for ACSVR.

Table 2.1: Interaction Model for ACSVR

Objective	• The purpose of the Adaptive Comfort System in Virtual Reality (ACSVR) is to reduce motion sickness by tracking heart rate and eye movement, adjusting VR environment based on real-time physiological data, ensuring comfort and enhancing user enjoyment.
User Flow	• **Entry Point:** Users enter the VR world after setting up their play boundary. An introduction guides them through the setup and initial use of the ACSVR system. • **Navigation:** Users navigate using handheld controllers. Movement within the virtual space is facilitated by pointing and pressing buttons. • **Interaction:** User can create their comfort profile both before and after motion sickness is detected. In the profile, they may

	set the maximum heart rate to pop-up a warning message or features such as their preferred display of VR World. • **Transitions:** N/A to ACSVR
Types of Interaction	• **Direct Interaction:** Users can directly interact with the ACSVR by using controllers. • **Indirect Interaction:** N/A to ACSVR • **Semi-Direct Interaction:** N/A to ACSVR
Narrative Integration	N/A to ACSVR
Physical Movement	N/A to ACSVR
Viewpoint Design	• **Transitions**: N/A to ACSVR • **Avoid Discomfort**: Based on the comfort profile set, transitions are designed with gradual changes in the visual field.
Embodiment	• **Physical Presence**: N/A to ACSVR
User Training	• **Training Approach**: Before the user enters the VR environment, users will be prompted to set up the play area, based on the room the user is in. After this, users will be taught about what ACSVR is, and then prompt the user if they want to activate this feature. They are also allowed to set up a personalized comfort profile that will only be saved on the personal device.
Testing and Iteration	• **Feedback Collection**: User feedback is collected through in-app surveys and user testing sessions • **Model Evolution**: The interaction model will continuously update based on user feedback and analytics data. Regular updates will be scheduled to enhance the overall comfort of the VR experience.

Wireframe

Wireframes are crucial for sketching the basic blueprint and flow of a design, establishing the foundational structure and layout. They guide the development of detailed visual elements and functionality, serving as an essential planning tool before creating mock-ups and testing user interaction with prototypes (Green & Labrecque, 2023). After conducted task analysis, user flow and interaction model for our persona, Sarah Lopez, we then started to visualize the design solutions with a wireframe:

Figure 2.3: Set Up Play Boundary

As shown in Figure 2.3, after VR device is turned on by Sarah, she will first ask to set up the play boundary. This is the normal procedure in VR sessions to prevent users from bumping into physical objects or walls while immersed in virtual environments, minimizing the risk of injury.

Figure 2.4: Set Up ACSVR

After play boundary is set, Sarah will be asked whether to set up the adaptive comfort system, as demonstrated in Figure 2.4.

Figure 2.5: Browse Home Page

Figure 2.5 shows the home page of VR environment. Sarah will be allowed to browse the home page after setting up the ACSVR. Icon of heart rate monitor and eye tracker will be on the top right side, indicating her current heart rate and eye movements and pupil dilation. In her case, she will be using VR to develop a VR game. Therefore, development app will be chosen.

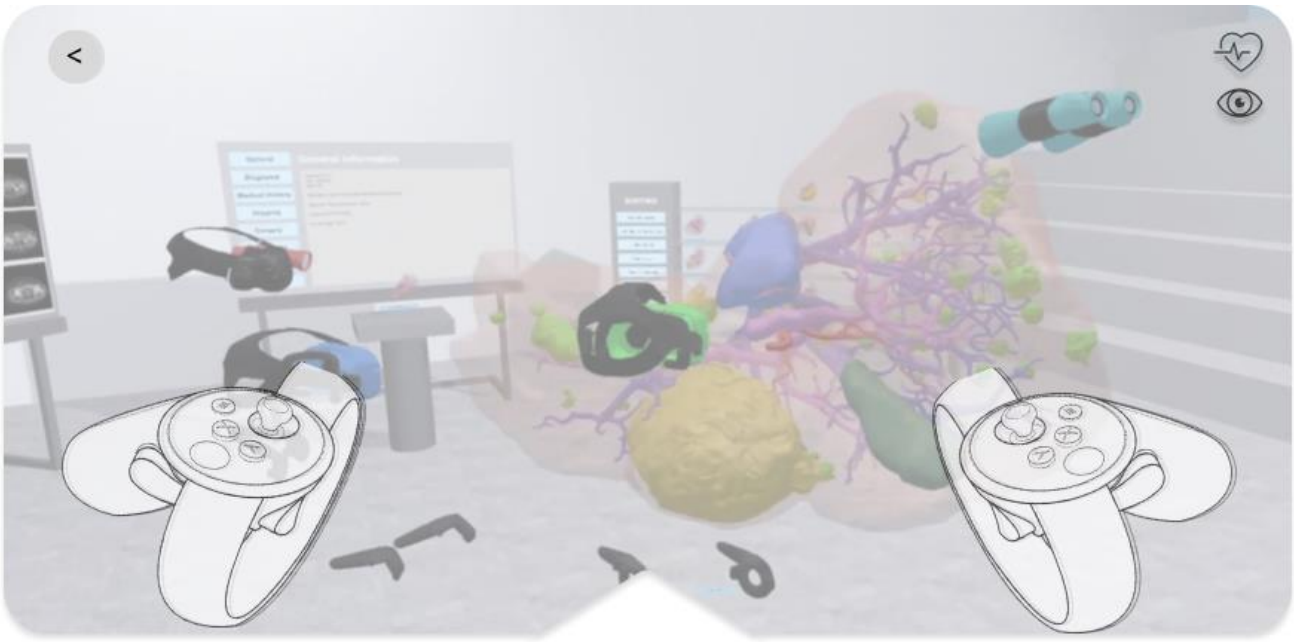


Figure 2.6: Developing VR Game

Figure 2.6 shows that Sarah is developing the game. Heart rate monitor and eye tracker will be running to detect motion sickness in real-time.

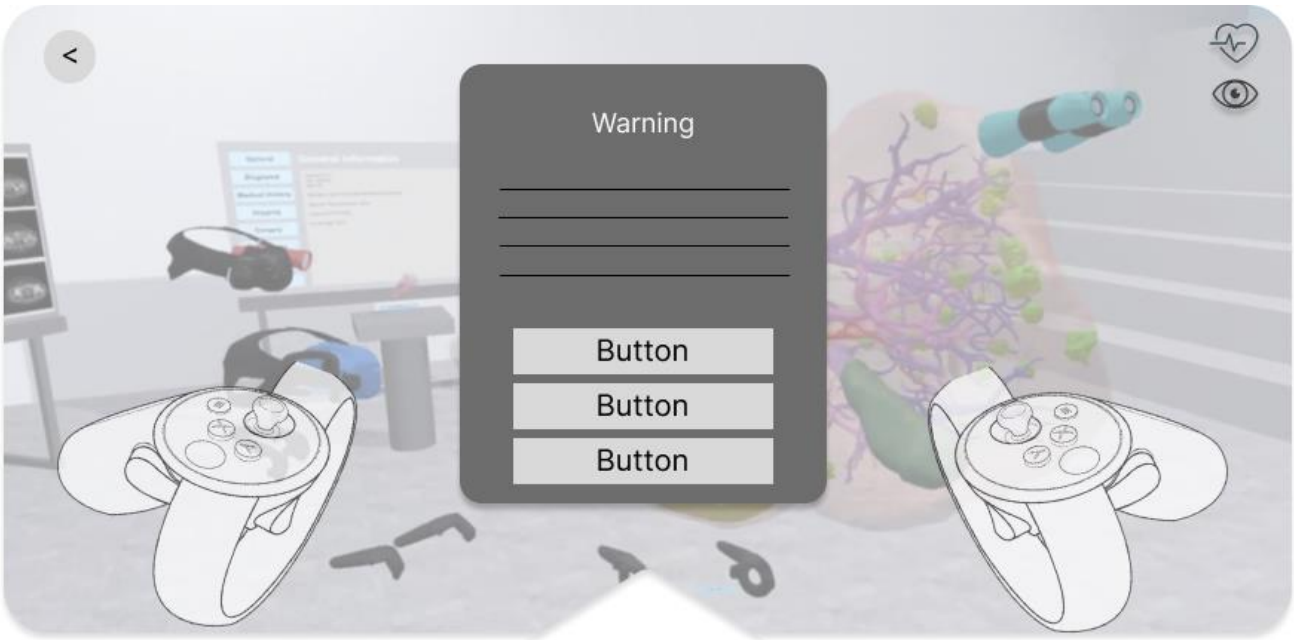


Figure 2.7: Motion Sickness Detected

Figure 2.7 shows that once motion sickness is detected (irregular heart rate / abnormal eye movements), a pop-up message will be displayed to warn the user. Sarah could make different decisions by clicking different buttons.

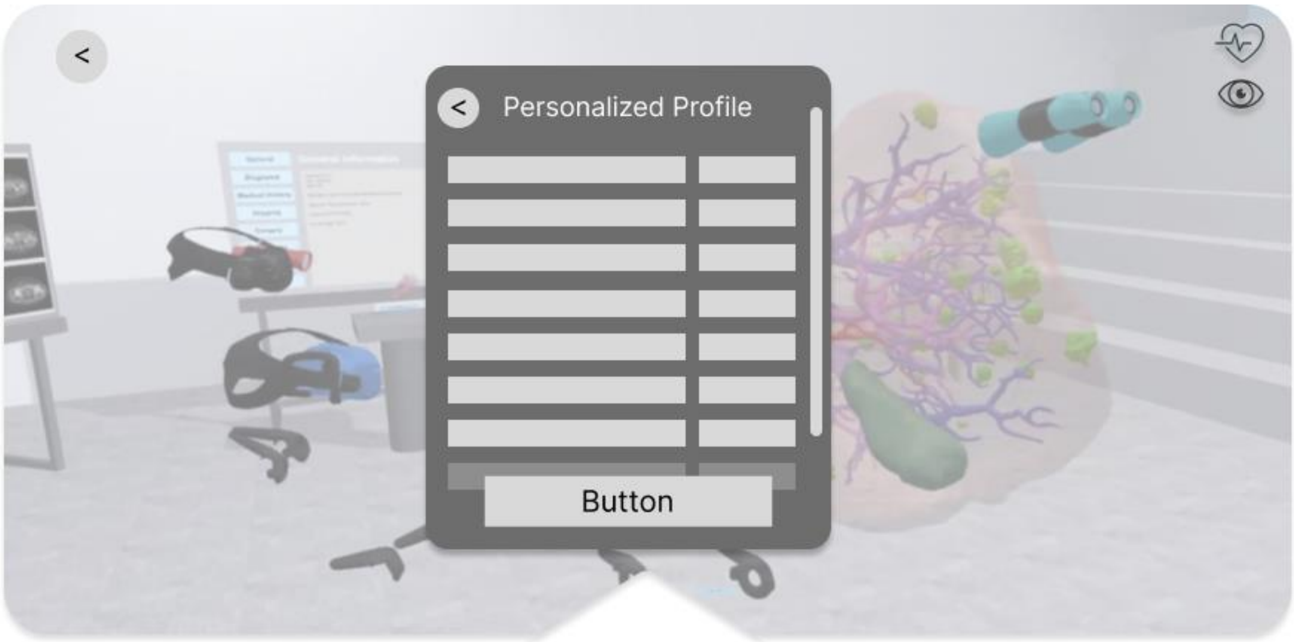


Figure 2.8: Customizing Personalized Comfort Profile

As shown in Figure 2.8, by using ACSVR, Sarah can create her own comfort profile. If motion sickness is detected, she may choose to activate her preset profile to adjust the VR environment. This personalized feature could help Sarah to adapt the motion sickness.

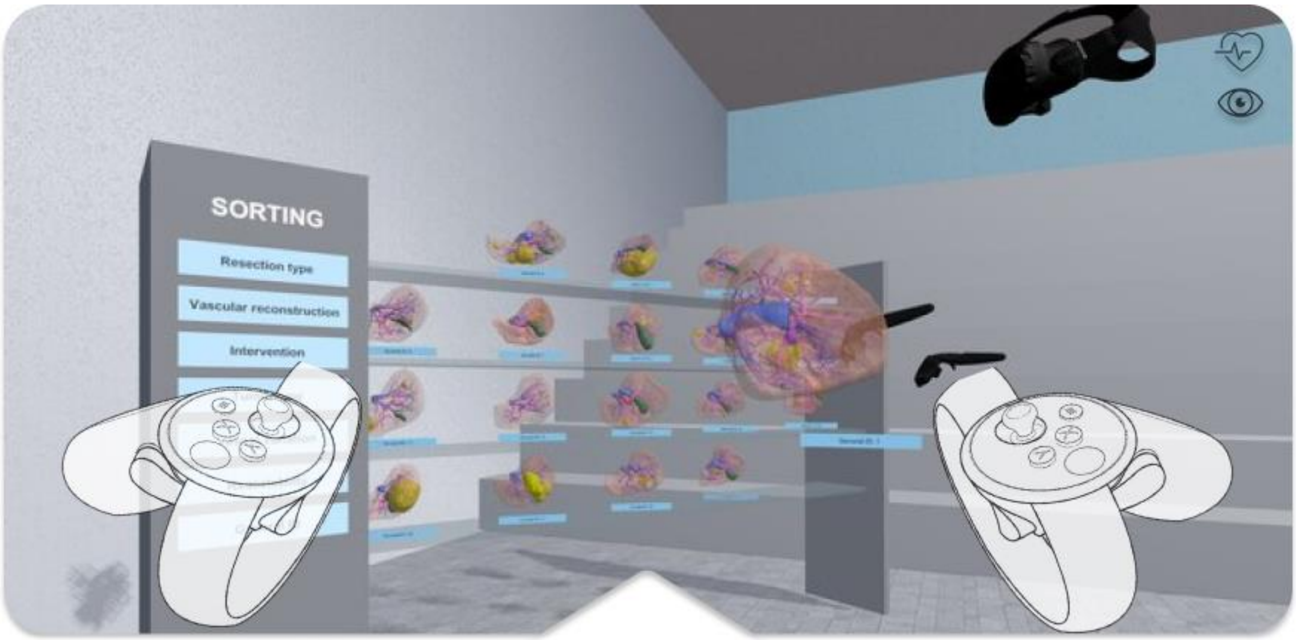


Figure 2.9: Game Testing

Figure 2.9 shows the process of game testing. Sarah will be testing the game time by time in her development process. The adaptive comfort system will continue working to ensure a comfortable and productive environment during her VR development sessions.

Summary of Milestone 2

In this milestone, we focused on the ideation and conceptualization phases of developing the Adaptive Comfort System for Virtual Reality (ACSVR) for motion sickness users. By employing task analysis, we dissected the activities necessary for achieving comfort during VR development, specifically for our persona, Sarah Lopez. This process highlighted the importance of breaking down complex tasks into manageable steps, ensuring a thorough understanding of user needs and expectations.

We also explored the user flow, which provided a structured pathway to navigate the ACSVR system from initial setup to real-time adjustments during VR use. This visualization helps in ensuring a seamless and productive ACSVR development.

The interaction model laid the groundwork for a great user experience by detailing how users interact with the ACSVR system. By understanding these interactions, we can create a better experience that effectively addresses motion sickness.

Lastly, wireframes served as an essential planning tool, guiding the development of detailed visual elements and functionality. These visualizations helped us envision the design solutions, ensuring that the final product meets the user's needs and provides a comfortable and efficient VR development environment.

In short, the ideation and conceptualization phases provided valuable insights into user needs, forming a strong foundation for the subsequent stages of development. By focusing on detailed task analysis, comprehensive user flow, and an efficient interaction model, we are well-equipped to create a system that significantly improves user comfort and productivity in VR environments.

Milestone 3 - Prototyping and Iteration

Heuristic Evaluation

Heuristic evaluation is a usability inspection method used to identify usability issues in user interface (UI) designs. Developed by Jakob Nielsen, this method involves evaluators examining the interface and assessing its compliance with established usability principles, known as heuristics. These principles have been adapted for various contexts, including augmented reality (AR) and virtual reality (VR). This scorecard, adapted by Audrey Labrie and Jinghui Cheng, includes metrics such as visibility of system status, match between the system and the real world, user control and freedom, consistency and standards, error prevention, recognition rather than recall, aesthetic and minimalist design, help users recognize, diagnose, and recover from errors, and help and documentation (Nielsen, 1995; Labrie & Cheng, 2020).

Applying heuristic evaluation to the ACSVR project ensures a user-centred, functional, and effective system that enhances the VR experience by reducing motion sickness. Key areas of focus include maintaining visibility of system status, using familiar real-world symbols, providing user control and freedom, ensuring consistency and standards, preventing errors, minimizing memory load, employing aesthetic and minimalist design, aiding error recovery, and offering comprehensive help and documentation. This structured approach helps identify areas for improvement, ensuring that the ACSVR system is intuitive, reliable, and enjoyable for users.

In evaluating the Adaptive Comfort System for Virtual Reality (ACSVR) project, we use a structured approach provided by the Interaction Design Foundation's scorecard. This involves rating specific heuristics on a scale of 0 to 4: 0 indicating that it no problem or issue, 1 means cosmetic or minimal issue, 2 meaning that it is a minor issue needing a ow-priority fix, 3 being a major problem requiring a high-priority fix, and 4 being critical issue.

We distributed this scorecard with Group UX-2-1 and UX-4-2 to conduct heuristic evaluation for ACSVR:

First Heuristic Evaluation

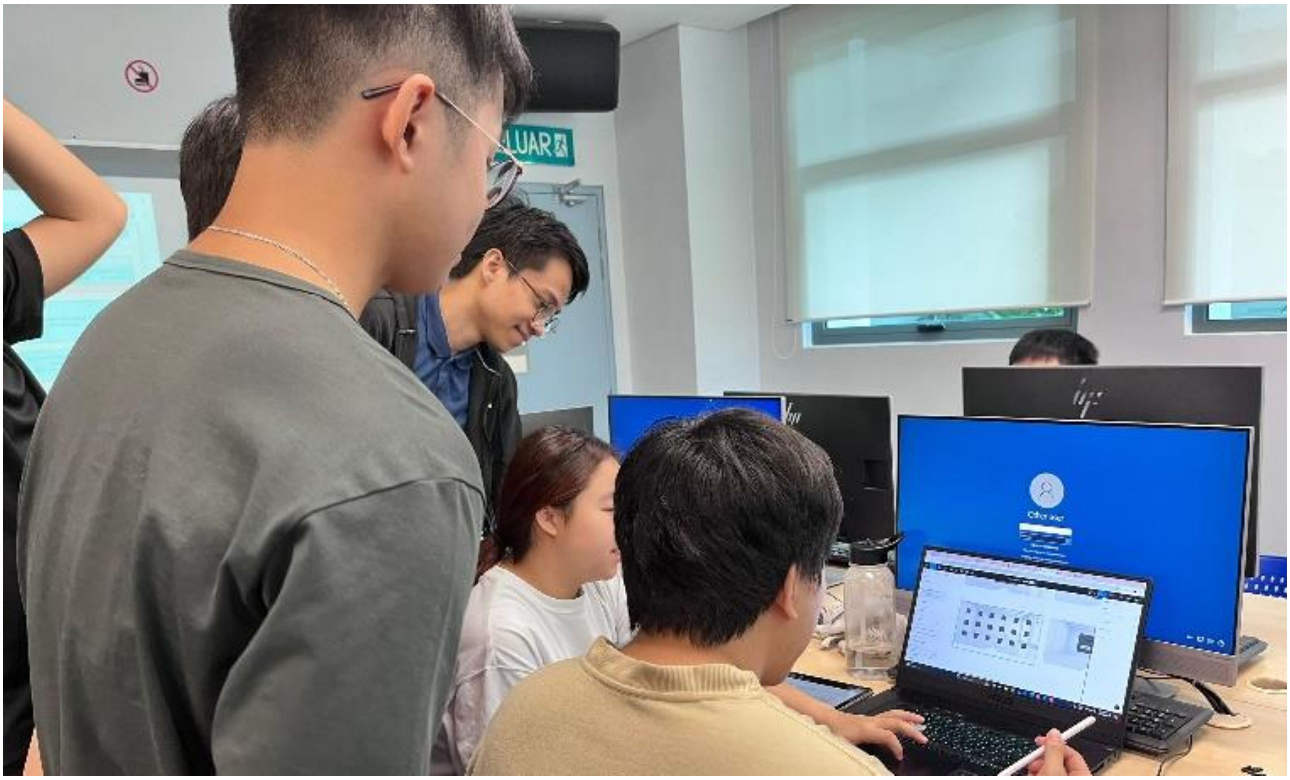


Figure 3.1: Heuristic Evaluation 1 (UX-2-1)

Table 3.1 shows the findings from conducting heuristic evaluation with group UX-2-1 (or refer Appendix 4).

Table 3.1: Findings of Heuristic Evaluation from UX-2-1

Heuristic	Rating
Visibility of system status.	0
Match between the system and the real world.	0
User control and freedom.	1
Consistency and standards.	1
Error prevention.	1
Recognition rather than recall.	0
Aesthetic and minimalist design	0
Help users recognize, diagnose, and recover from errors.	1
Help and documentation.	0

Several improvements are recommended: adding a back button for easier navigation, aligning symbols for better visual coherence, and allowing users to customize or use default boundary settings. Additionally, providing options to display heart rate with adjustable transparency, colour, and stability, and adding a setting to adjust how the ACSVR system affects the environment will significantly enhance user control and personalization. These changes aim to improve the overall user experience and functionality of the system.

Second Heuristic Evaluation

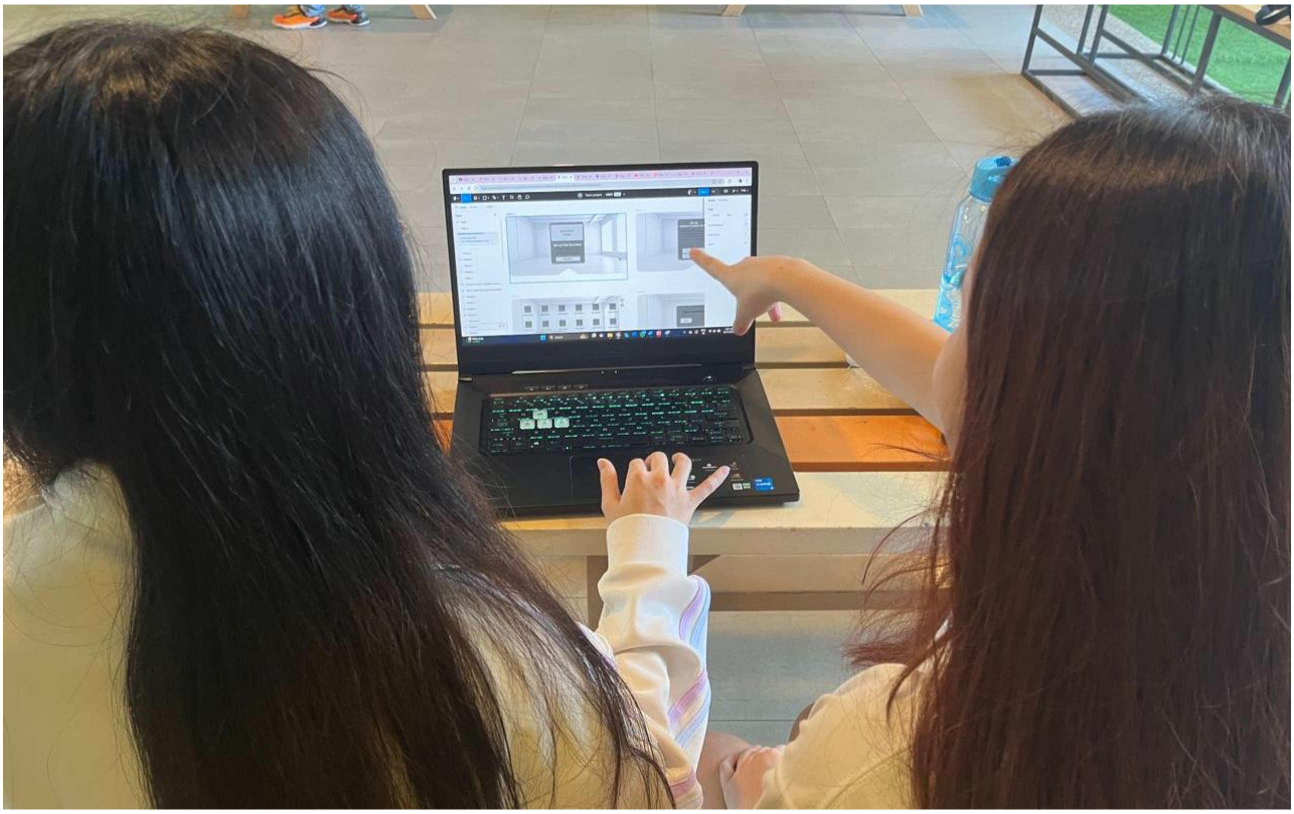


Figure 3.2: Heuristic Evaluation 2 (UX-4-2)

Table 3.2 shows the findings from conducting heuristic evaluation with group UX-4-2 (or refer Appendix 4).

Table 3.2: Findings of Heuristic Evaluation from UX-4-2

Heuristic	Rating
Visibility of system status.	0
Match between the system and the real world.	0
User control and freedom.	3

Consistency and standards.	0
Error prevention.	2
Recognition rather than recall.	0
Aesthetic and minimalist design	1
Help users recognize, diagnose, and recover from errors.	1
Help and documentation.	1

The heuristic evaluation highlighted the need for improved error prevention in the ACSVR system. The design can be enhanced by better utilizing space and padding for a cleaner layout. Additionally, there should be confirmation messages displayed after users make modifications to their personalized settings. Finally, it is crucial to provide clear descriptions for ACSVR to help users understand their functionalities and benefits.

Digital Mock-up

After reviewing and filtering all feedback from heuristic evaluation, we proceed with digital mock-up:

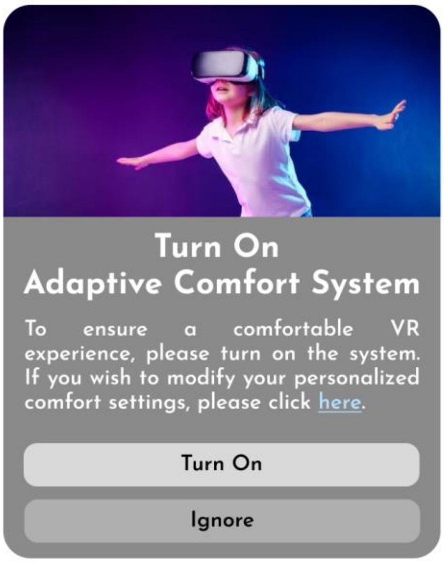


Figure 3.3: Set Up ACSVR

Figure 3.3 shows the first interface a user would see after entering VR. When users entered VR, they will be asked whether to turn on ACSVR or ignore. They can also modify the personalized comfort settings.

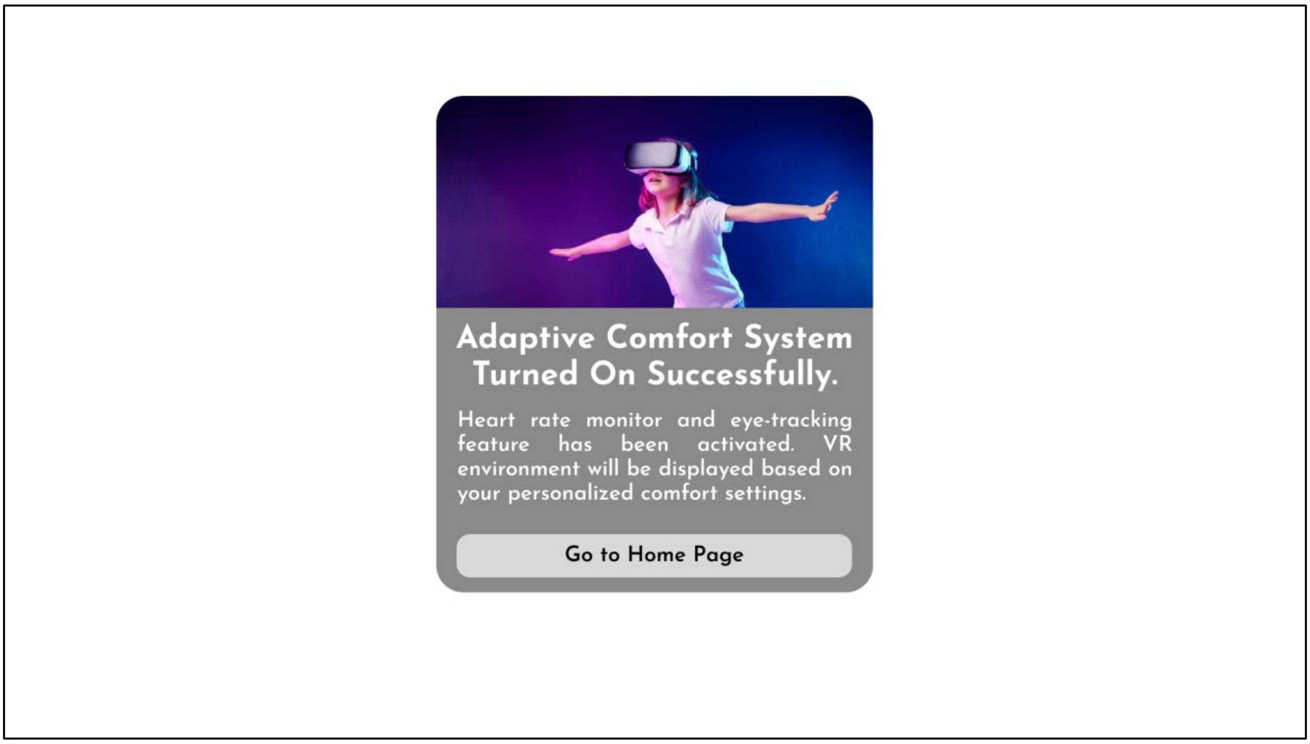


Figure 3.4: ACSVR Turned on Successfully

Figure 3.4 shows that a confirmation message will be displayed if ACSVR has turned on. They may direct to the home page after this.

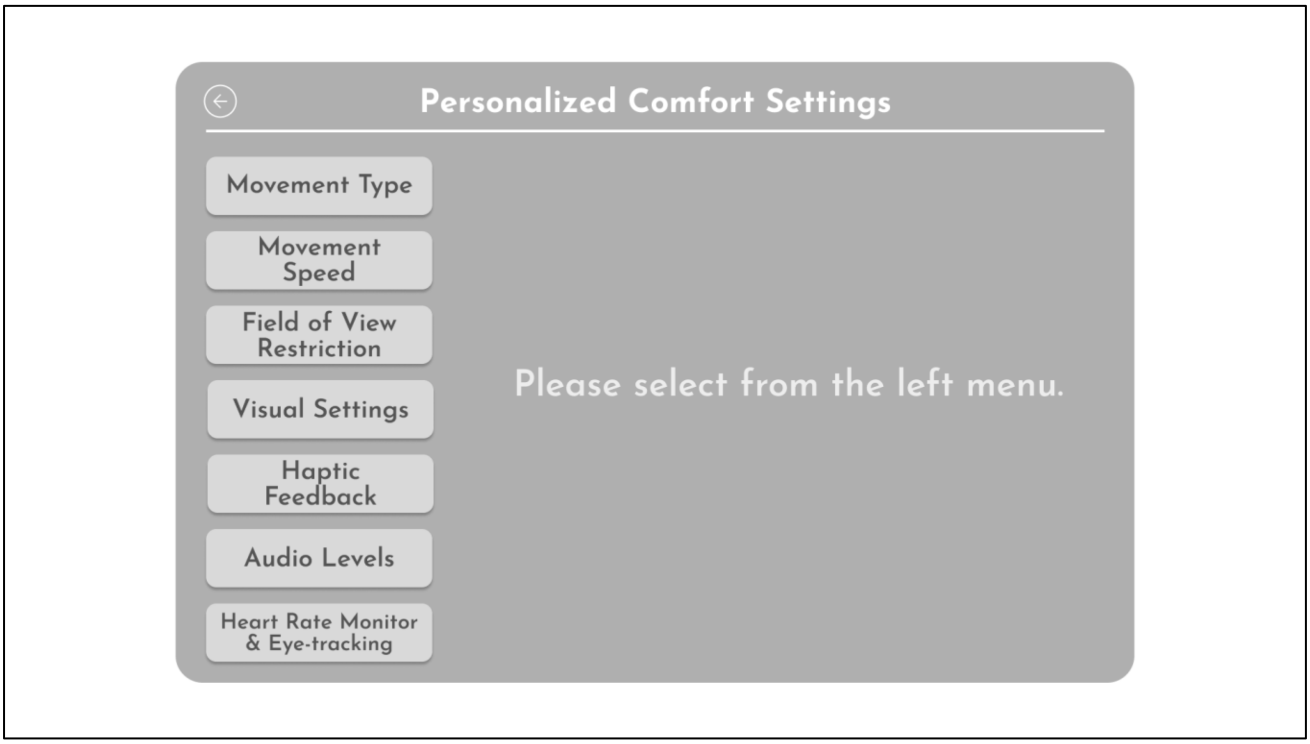


Figure 3.5: Personalized Comfort Settings

As shown in Figure 3.5, if users chose to modify their personalized comfort settings, they will be directed to above interface. They are asked to select the specific setting from the left menu they wish to modify. They can also escape from this interface by clicking the “back” button on top-left side.

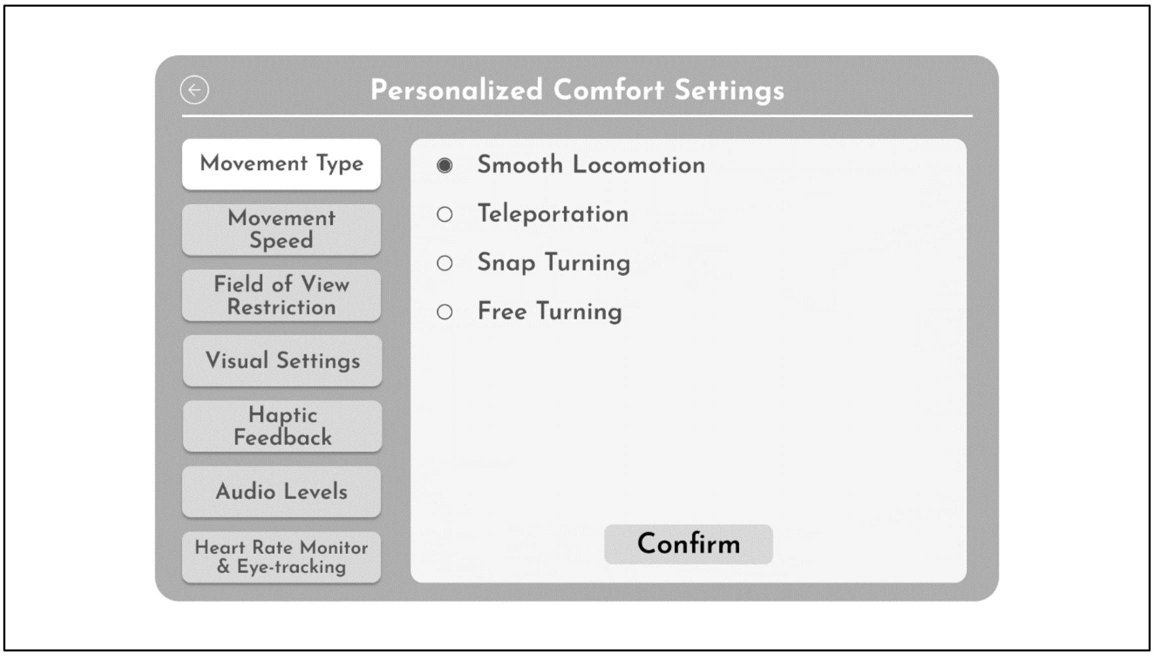


Figure 3.6: Movement Type Setting

Figure 3.6 shows the default setting for movement type in VR. Users may choose to change the movement type to teleportation, snap turning or free turning.

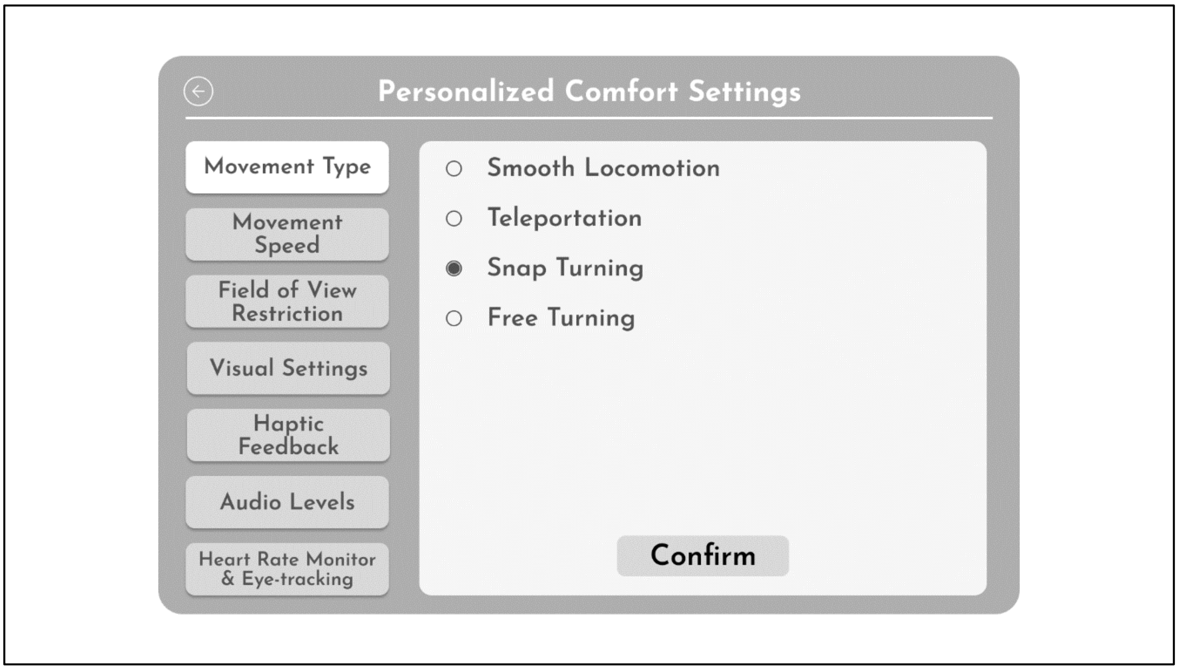


Figure 3.7: Modifying Movement Type Setting

Figure 3.7 shows the changing of setting for movement type.

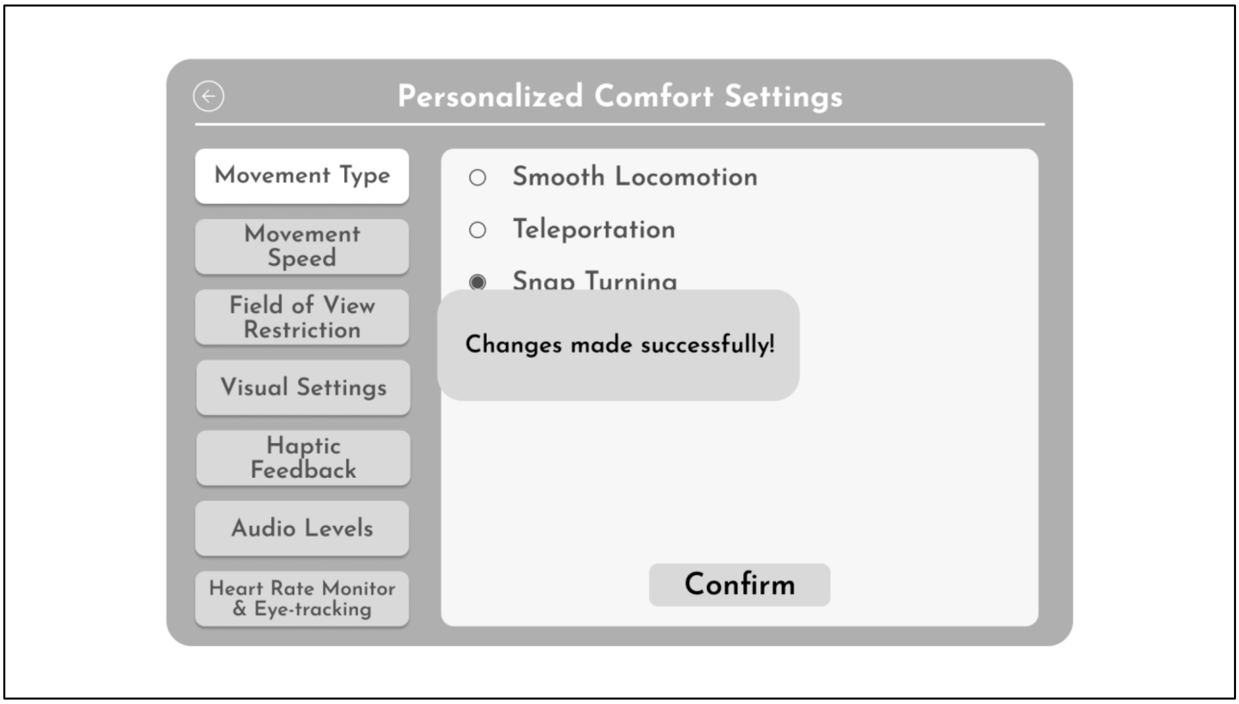


Figure 3.8: Confirm Modification for Movement Type

Figure 3.8 shows the confirmation on modifying movement type. After users click "confirm" button, a pop-up message will appear to inform users that changes have been made successfully.

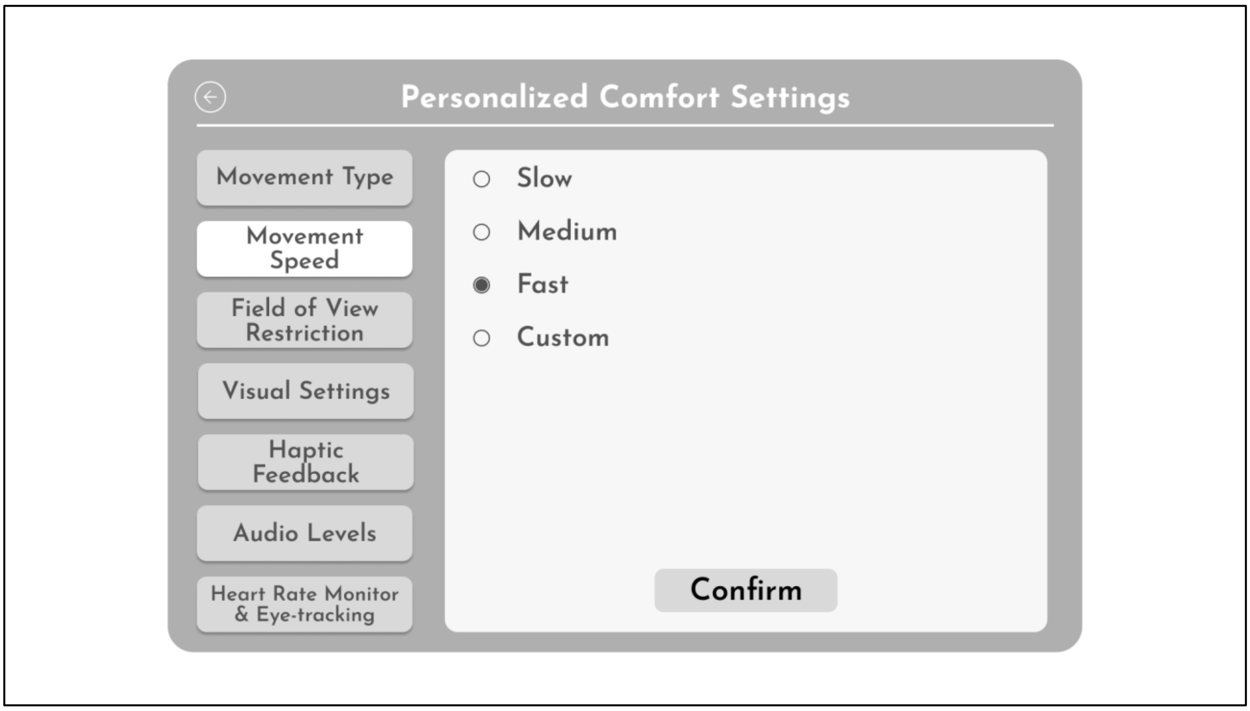


Figure 3.9: Movement Speed Setting

Figure 3.9 shows the default setting for movement speed in VR. Users may choose to change the movement speed to slow, medium or customize the speed.

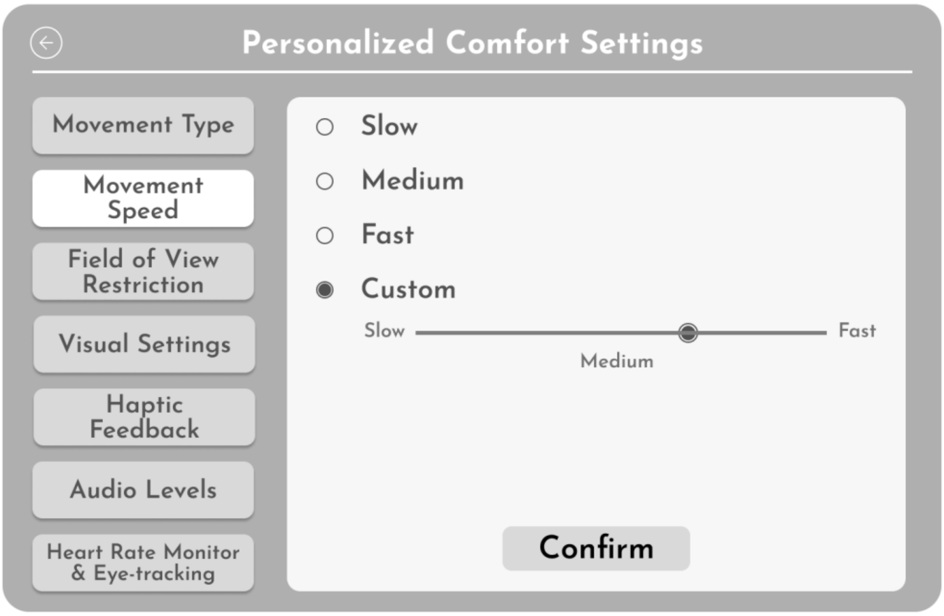


Figure 3.10: Customizing Movement Speed Setting

Figure 3.10 shows that users may customize the movement speed in VR. They can drag left or right to decide on the speed they want.

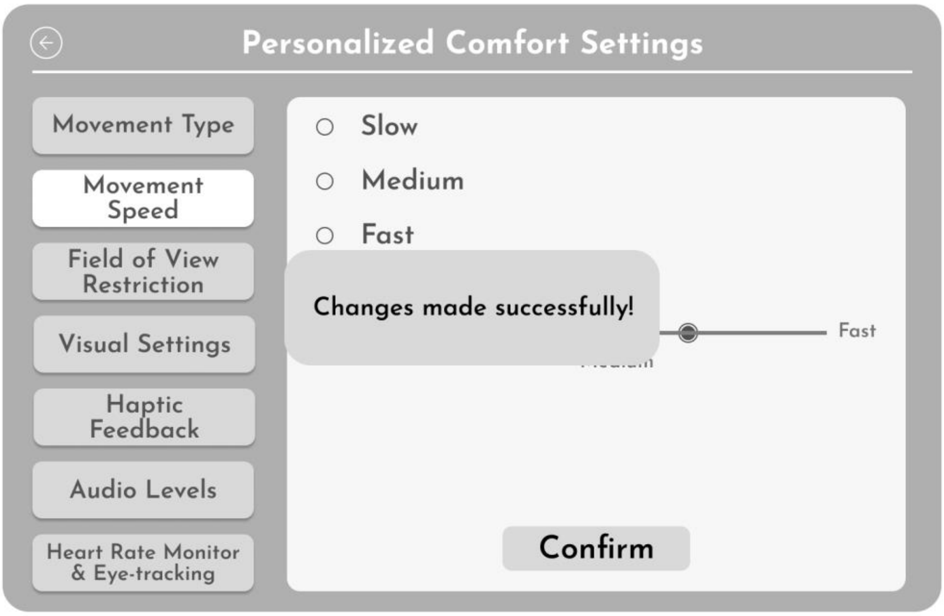


Figure 3.11: Confirm Modification for Movement Speed

As shown in Figure 3.11, after users click "confirm" button, a pop-up message will appear to inform users that changes have been made successfully.

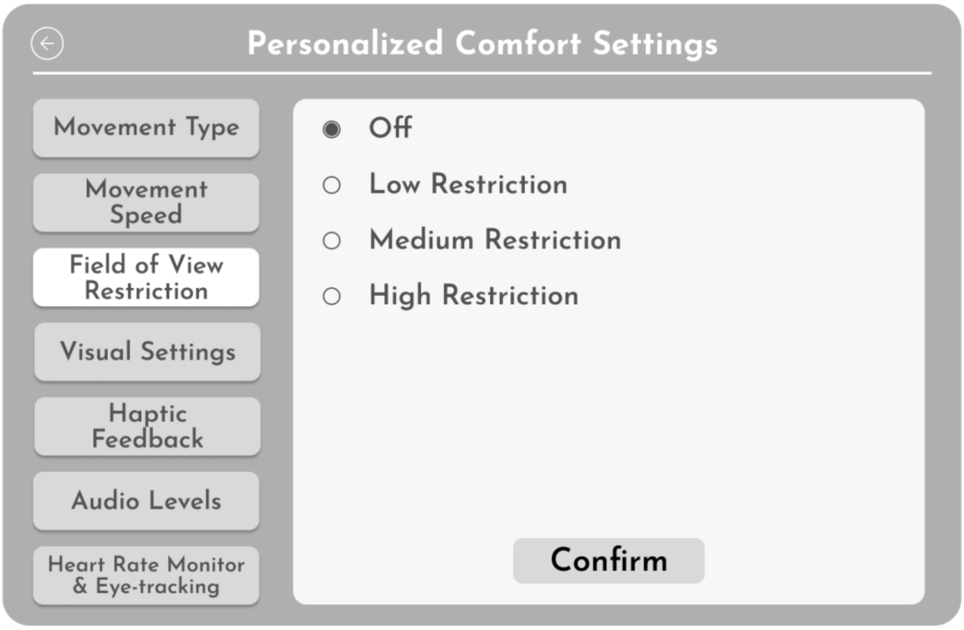


Figure 3.12: Field of View Restriction Setting

Figure 3.12 shows the default setting for field of view (FOV) restriction. Users may choose to change the FOV restriction to low, medium, or high.

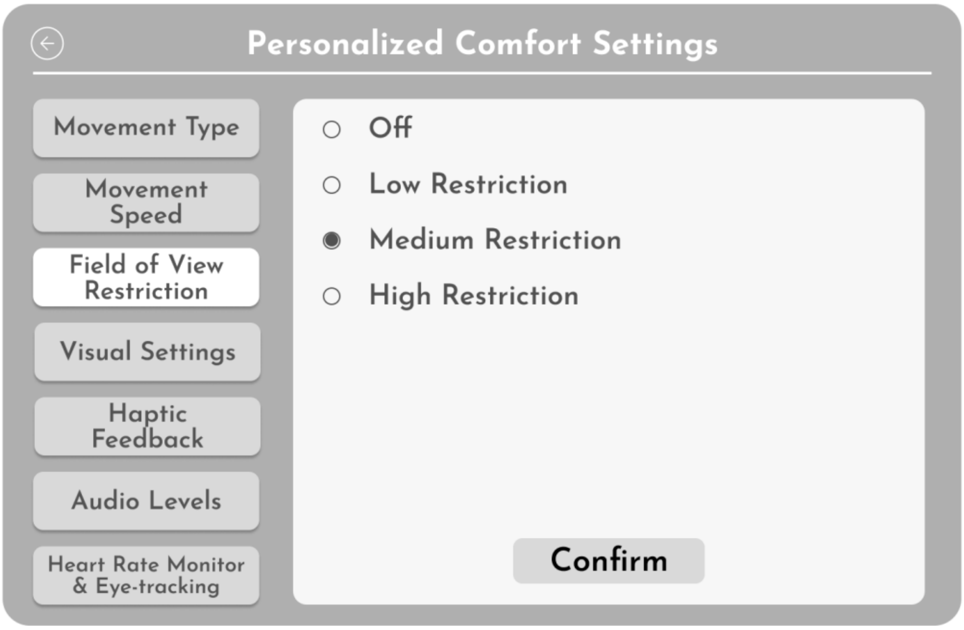


Figure 3.13: Modifying the FOV Restriction Setting

Figure 3.14 shows the modification of FOV restriction, from Off to Medium Restriction.

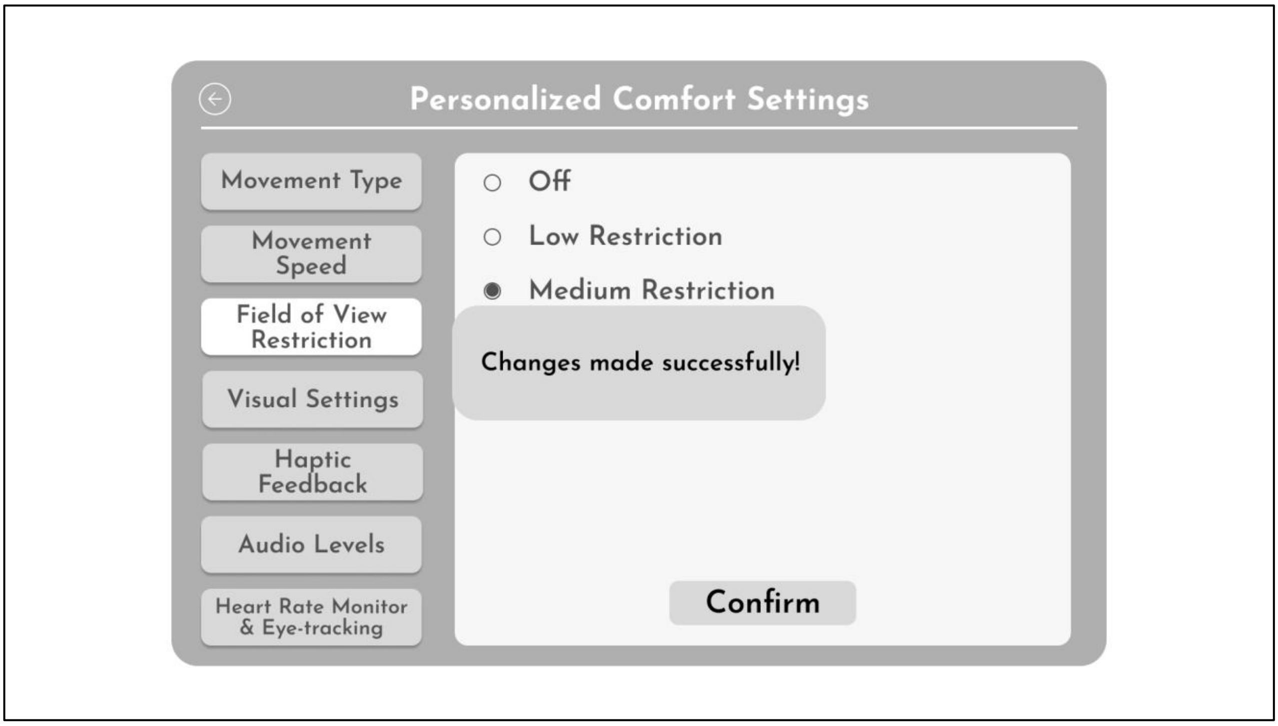


Figure 3.14: Confirm Modification for FOV Restriction

After users click "confirm" button, a pop-up message will appear to inform users that changes have been made successfully.

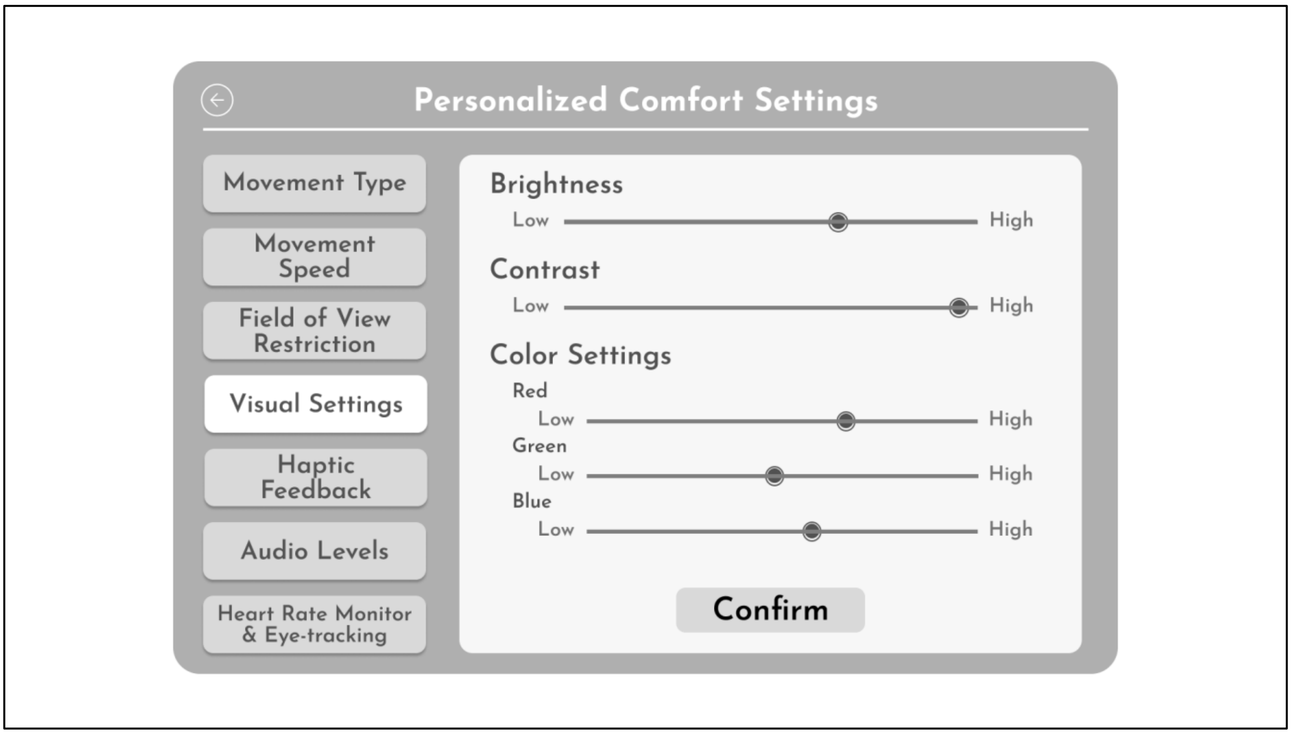


Figure 3.15: Visual Settings

Figure 3.15 shows the default visual settings. Users may choose to adjust on brightness, contrast and color settings.

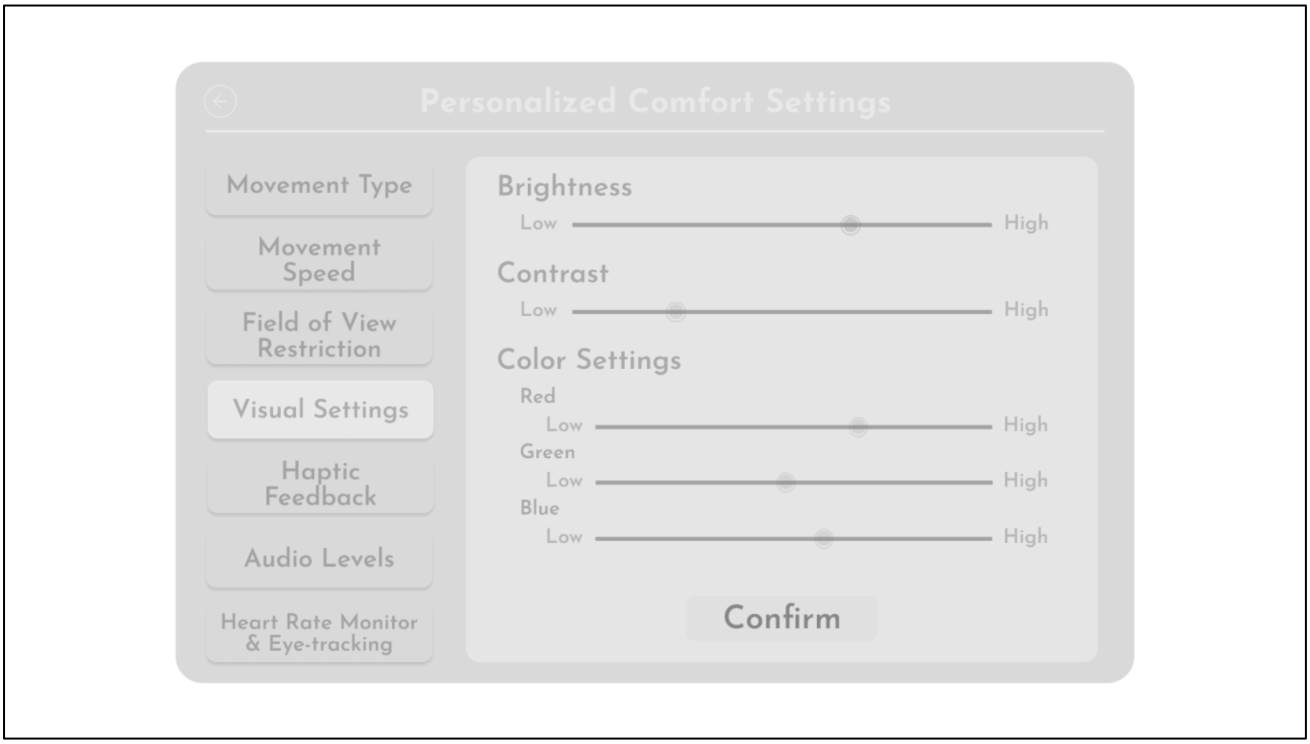


Figure 3.16: Modifying Visual Settings

Figure 3.16 shows the changes made if users adjust the contrast to low. The whole VR environment would be adjusted based on settings.

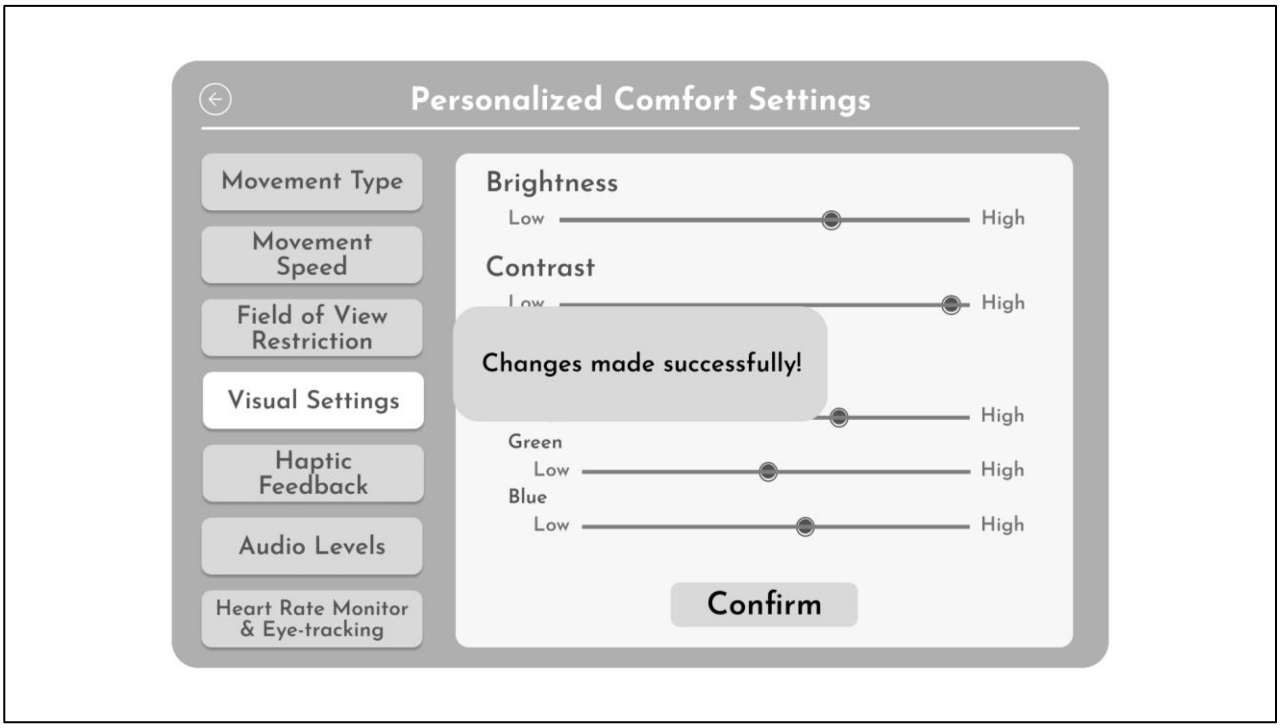


Figure 3.17: Confirm Modification on Visual Settings

As shown in Figuer 3.13, after users click “confirm” button, a pop-up message will appear to inform users that changes have been made successfully.

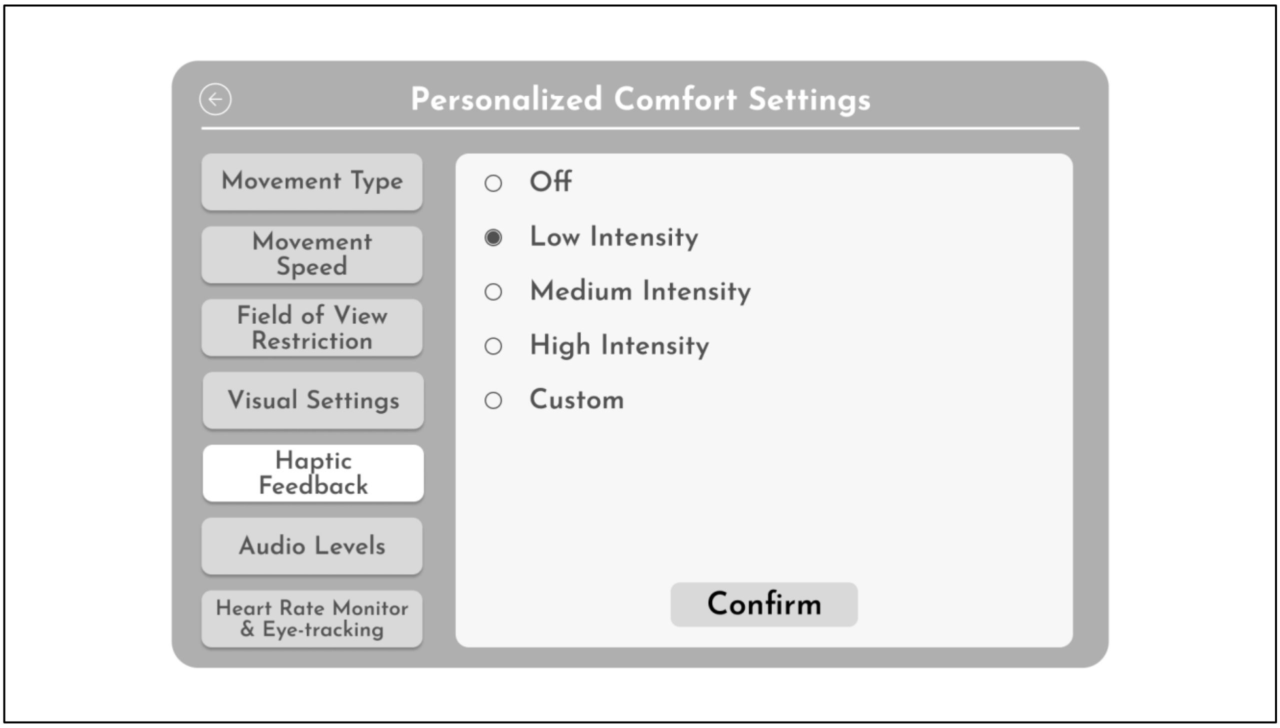


Figure 3.18: Haptic Feedback Setting

Figure 3.18 shows the default setting for field of view (FOV) restriction. Users may choose to change the haptic feedback to off, medium, high or customize.

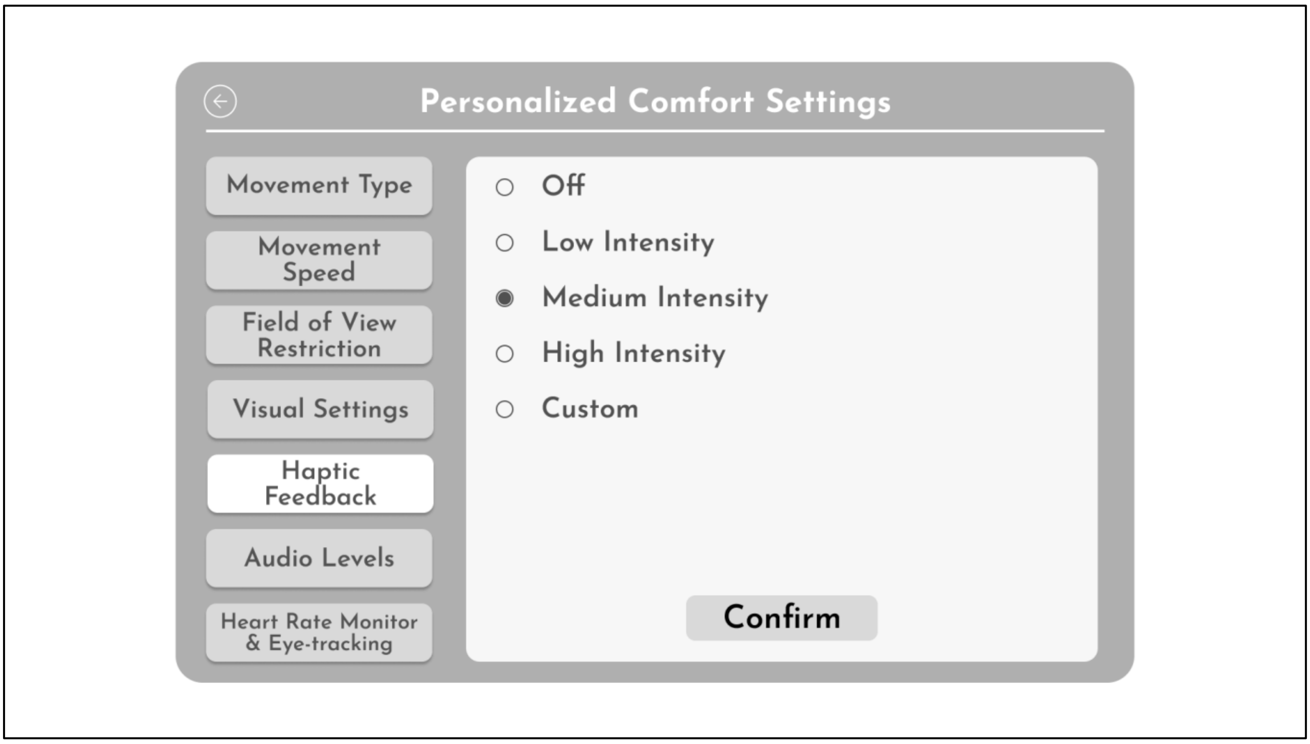


Figure 3.19: Modifying Haptic Feedback Setting

Figure 3.19 shows the modification of haptic feedback, from low intensity to medium intensity.

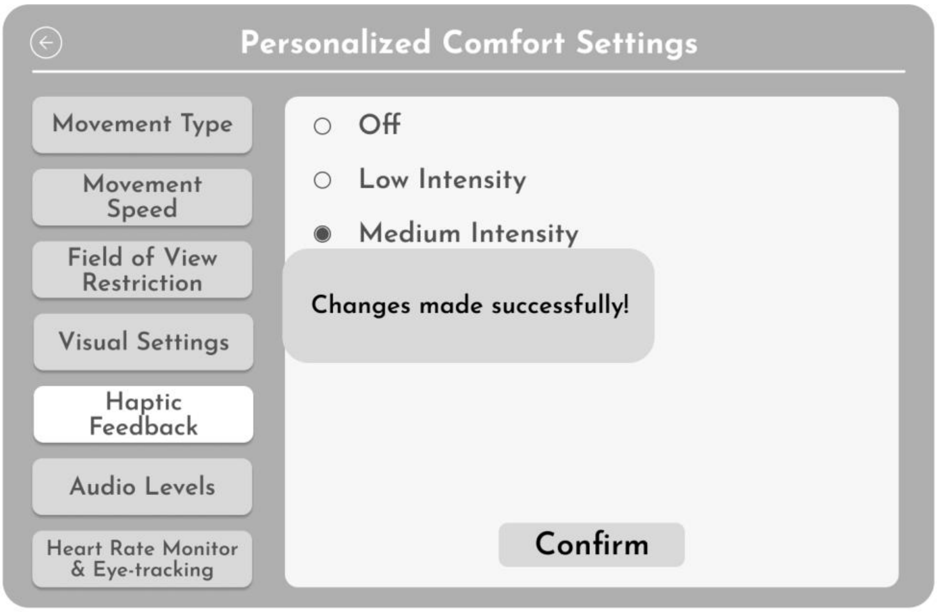


Figure 3.20: Confirm Modification on Haptic Feedback Setting

As shown in Figure 3.20, after users click “confirm” button, a pop-up message will appear to inform users that changes have been made successfully.

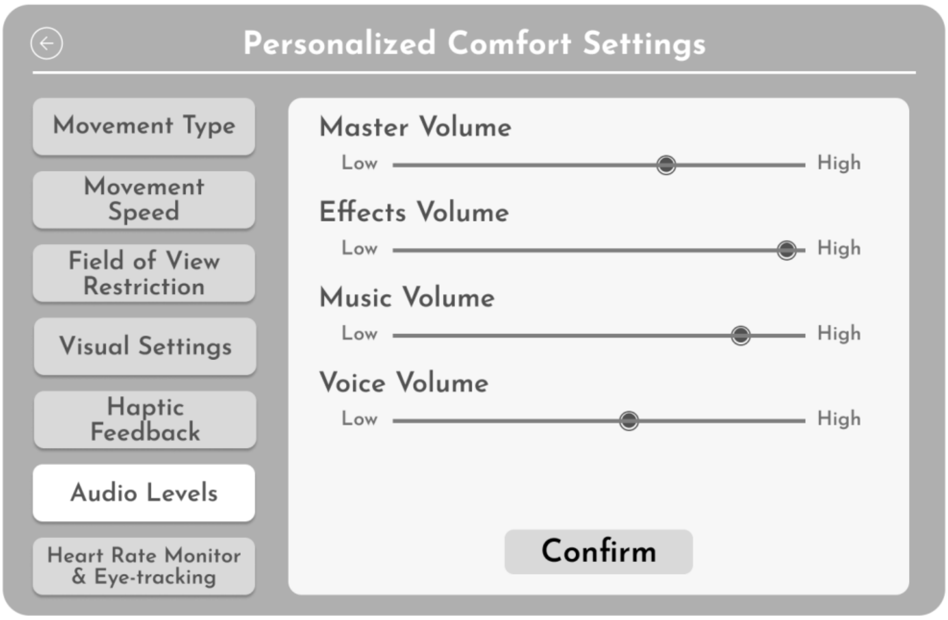


Figure 3.21: Audio Levels Setting

Figure 3.21 shows the default/previous setting for audio levels. Users may adjust the master volume, effects volume, music volume or voice volume by dragging it left or right.

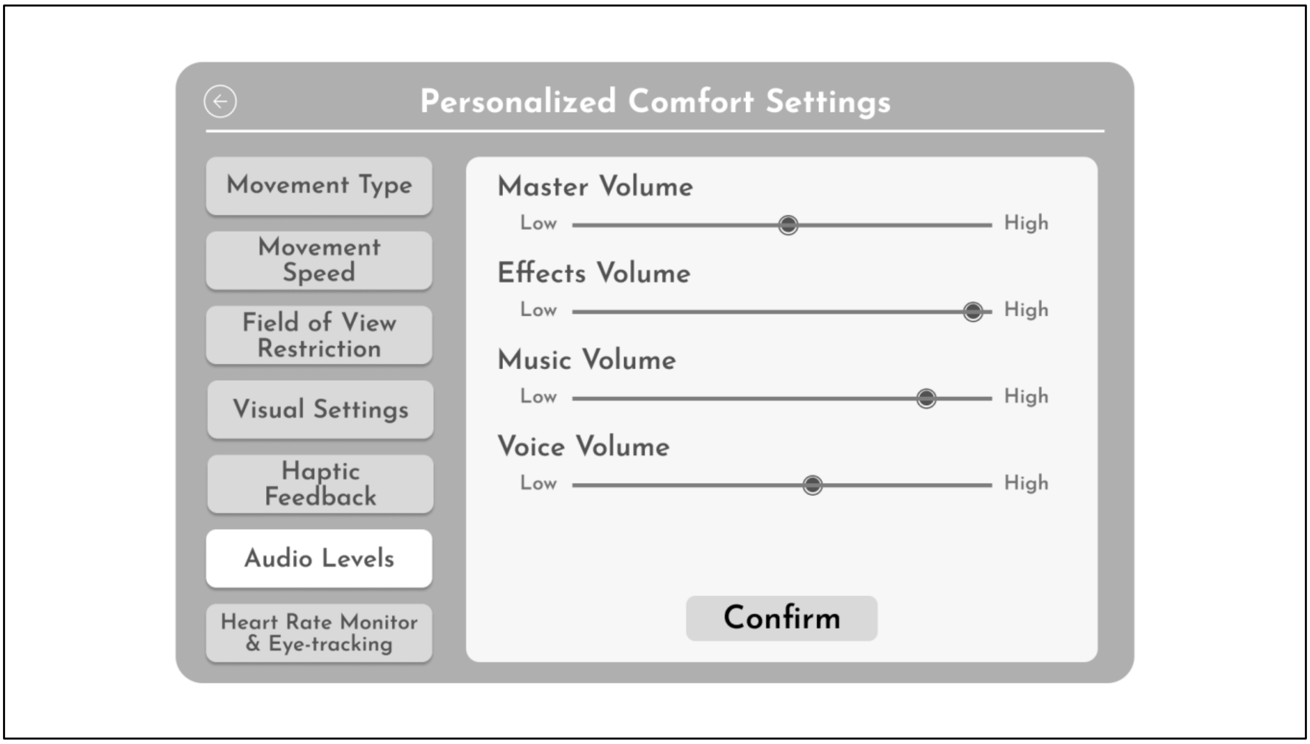


Figure 3.22: Modifying Audio Levels Setting

Figure 3.22 shows the modification of master volume, from high towards low.

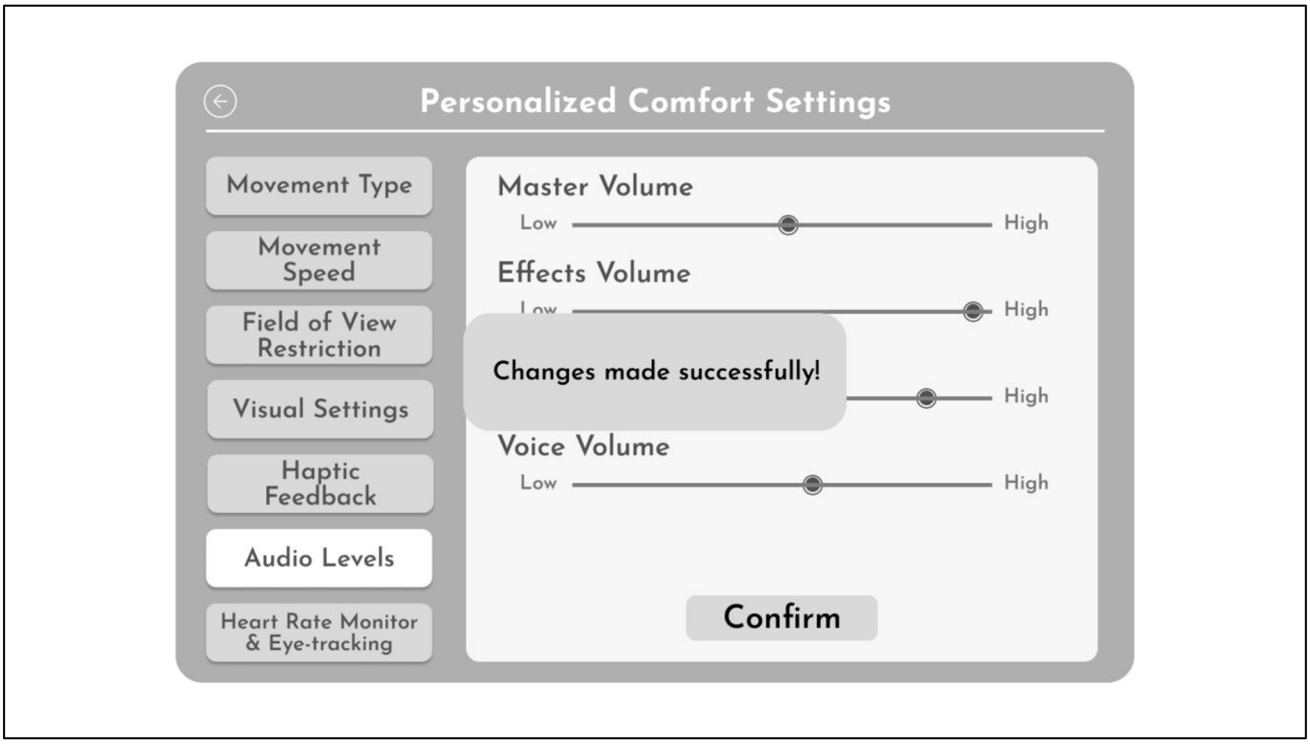


Figure 3.23: Confirm Modification on Audio Levels

As shown in Figure 3.23, after users click “confirm” button, a pop-up message will appear to inform users that changes have been made successfully.

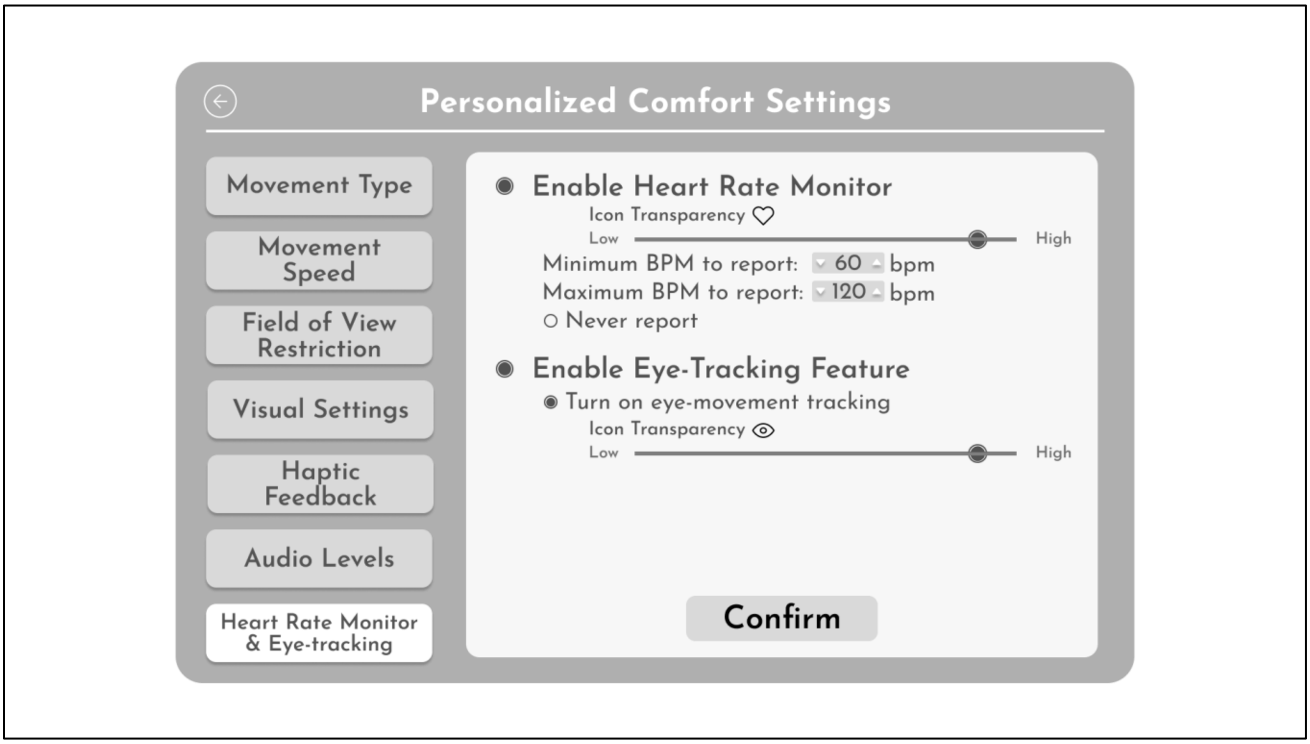


Figure 3.24: Heart Rate Monitor & Eye-tracking Setting

Figure 3.24 shows the default/previous setting for heart rate monitor and eye-tracking feature. Users may choose to enable or disable the heart rate monitor and eye-tracking feature. Besides that, they can adjust the icon's transparency for both. For heart rate monitor, they can set the minimum and maximum bpm to prompt warning messages.

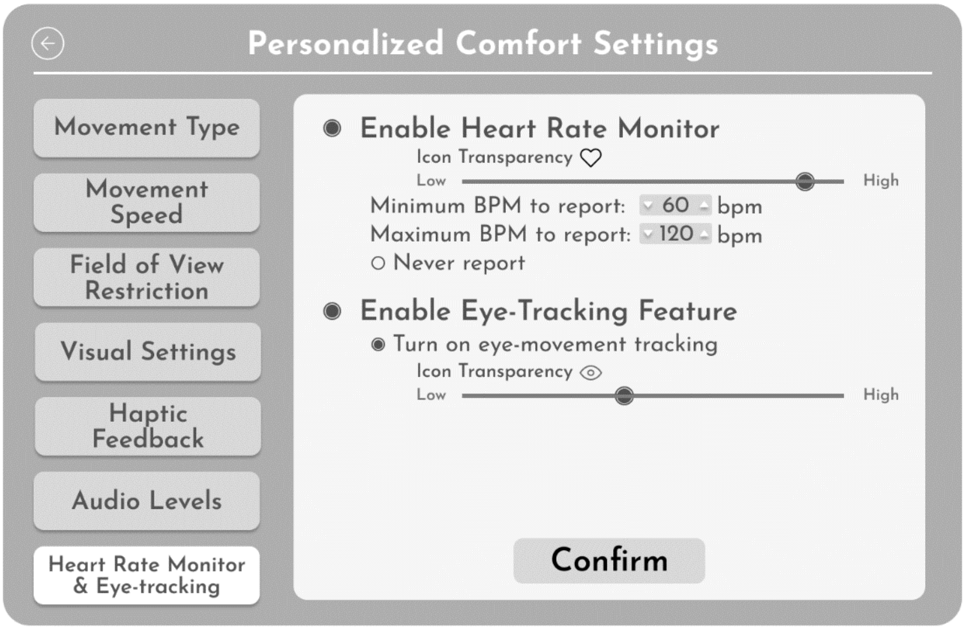


Figure 3.25: Modifying Heart Rate Monitor & Eye-tracking Setting

Figure 3.25 shows the modification on icon's transparency for eye-tracking feature.

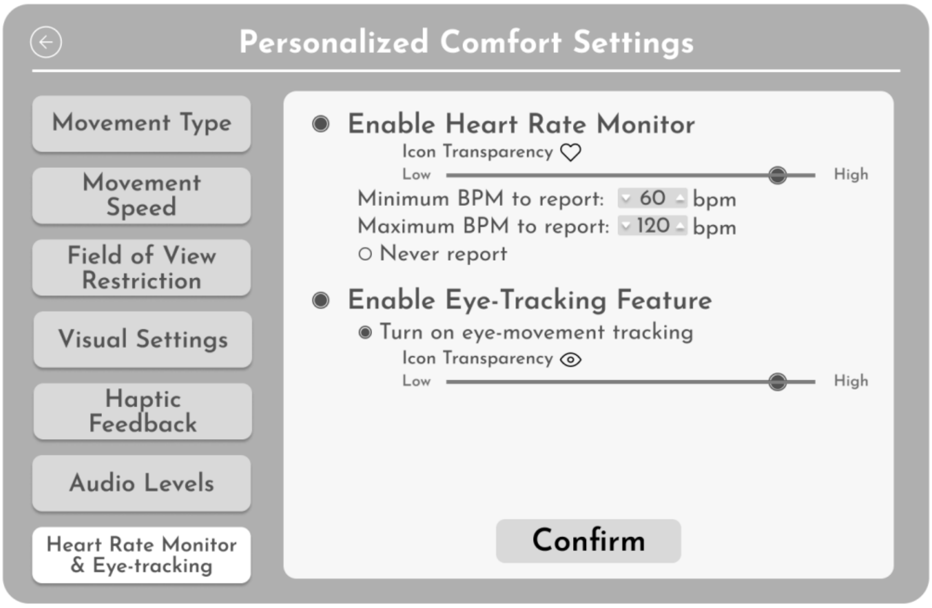


Figure 3.26: Confirm Modification on Heart Rate Monitor & Eye-tracking

As shown in Figure 3.26, after users click "confirm" button, a pop-up message will appear to inform users that changes have been made successfully.

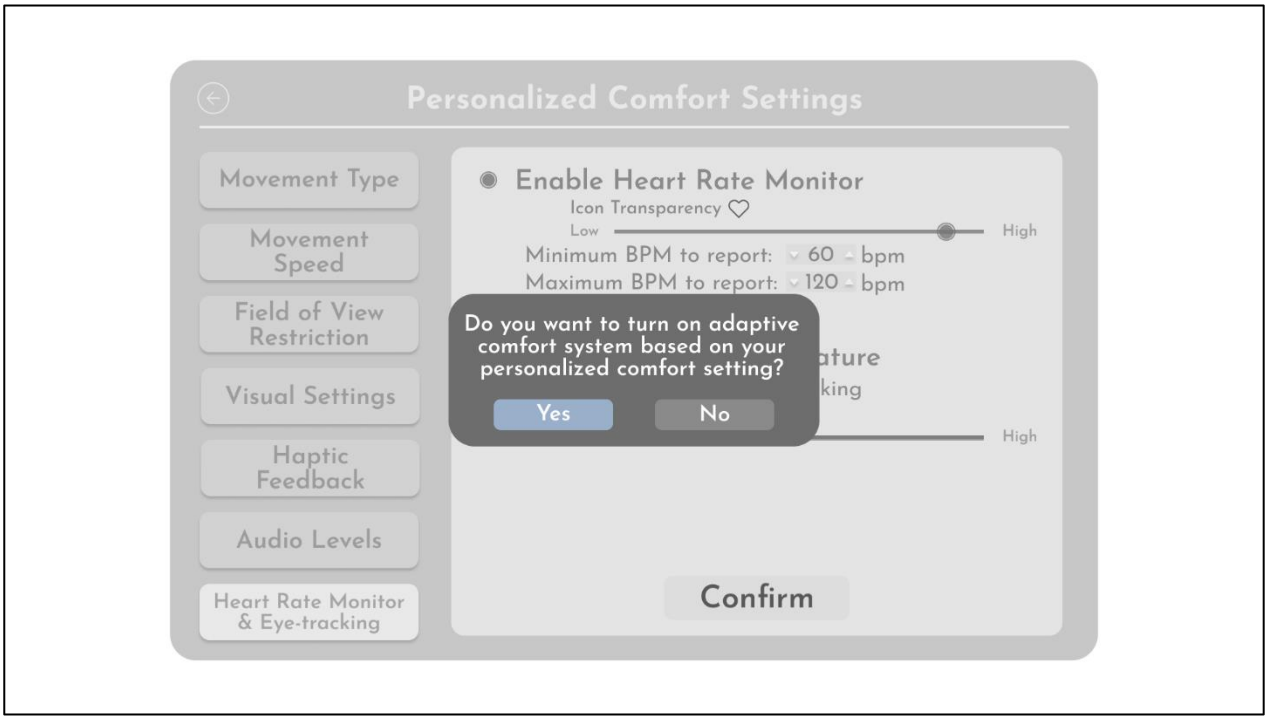


Figure 3.27: Selection on Turning On ACSVR

Figure 3.27 shows that users are asked whether to turn on ACSVR if they clicked the "back" button on the top-left after making any modifications on personalized comfort settings.

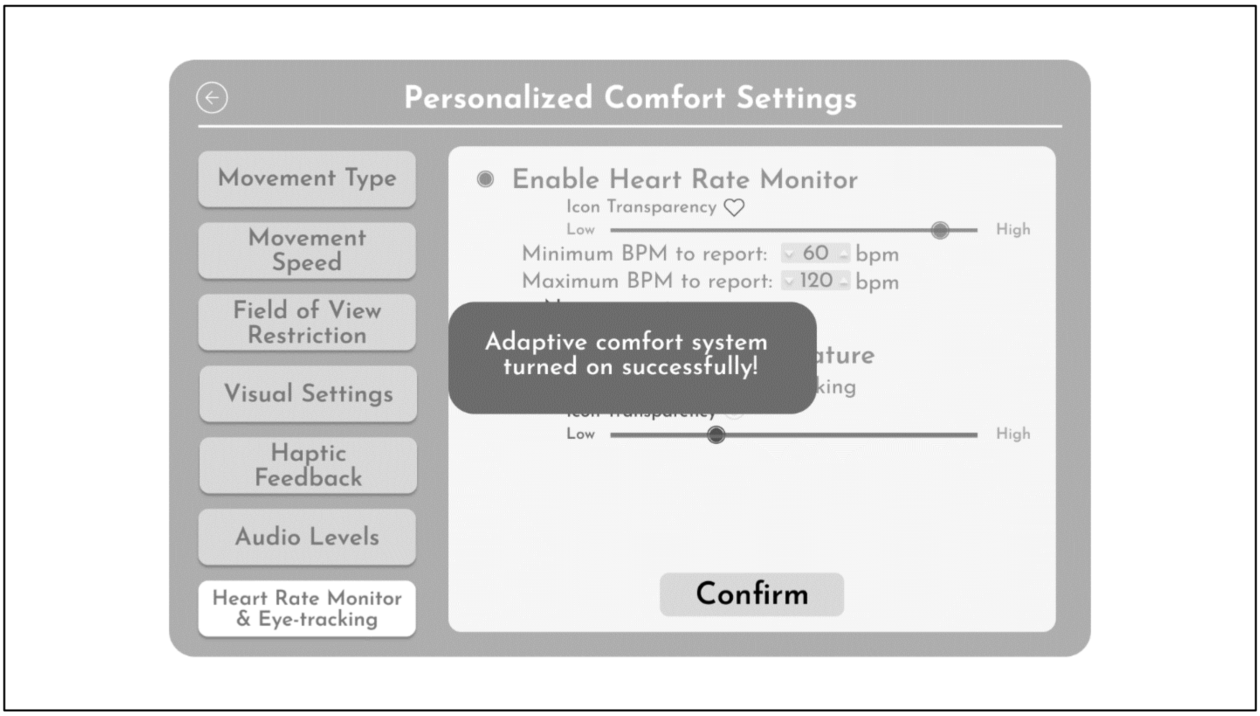


Figure 3.28: ACSVR Turned On Successfully

As shown in Figure 3.28, after users clicked on yes to turn on ACSVR, a pop-up message will appear to inform users that ACSVR has been turned on successfully.

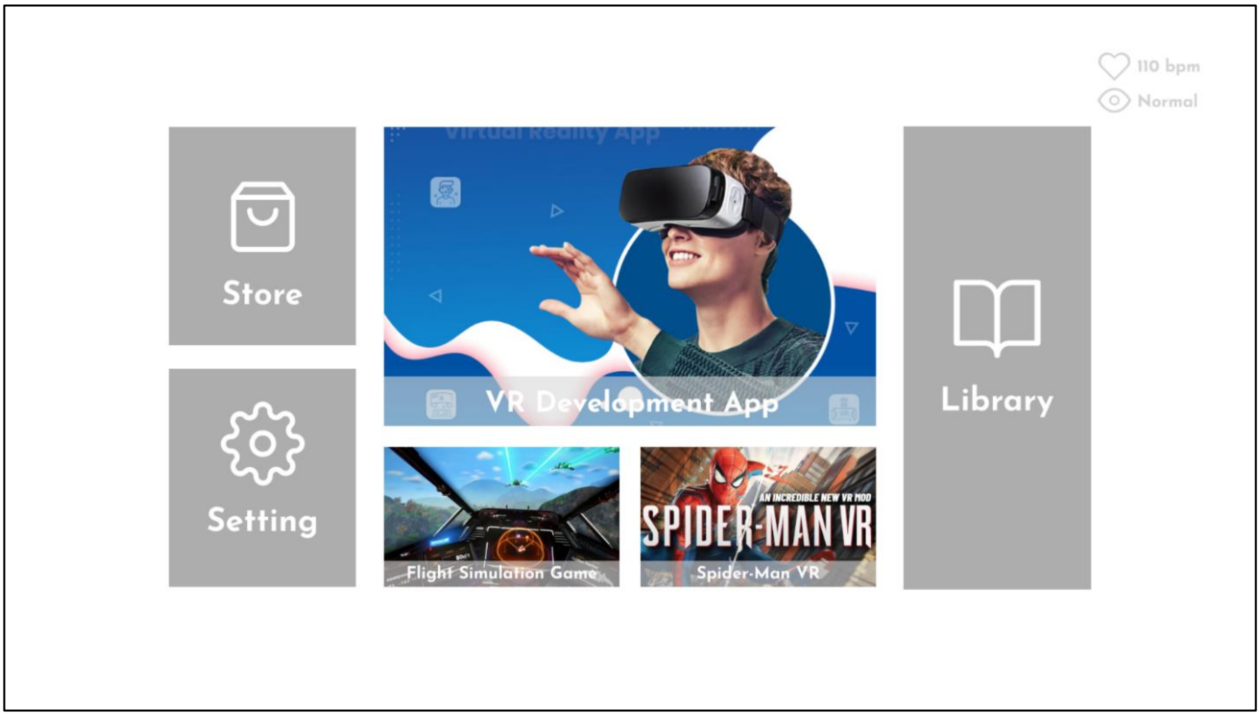


Figure 3.29: Home Page

As shown in Figure 3.29, after pop-up message shown, users will be directed to their home page. Real-time heart rate and eye movement are shown on the top-right side of the home page.

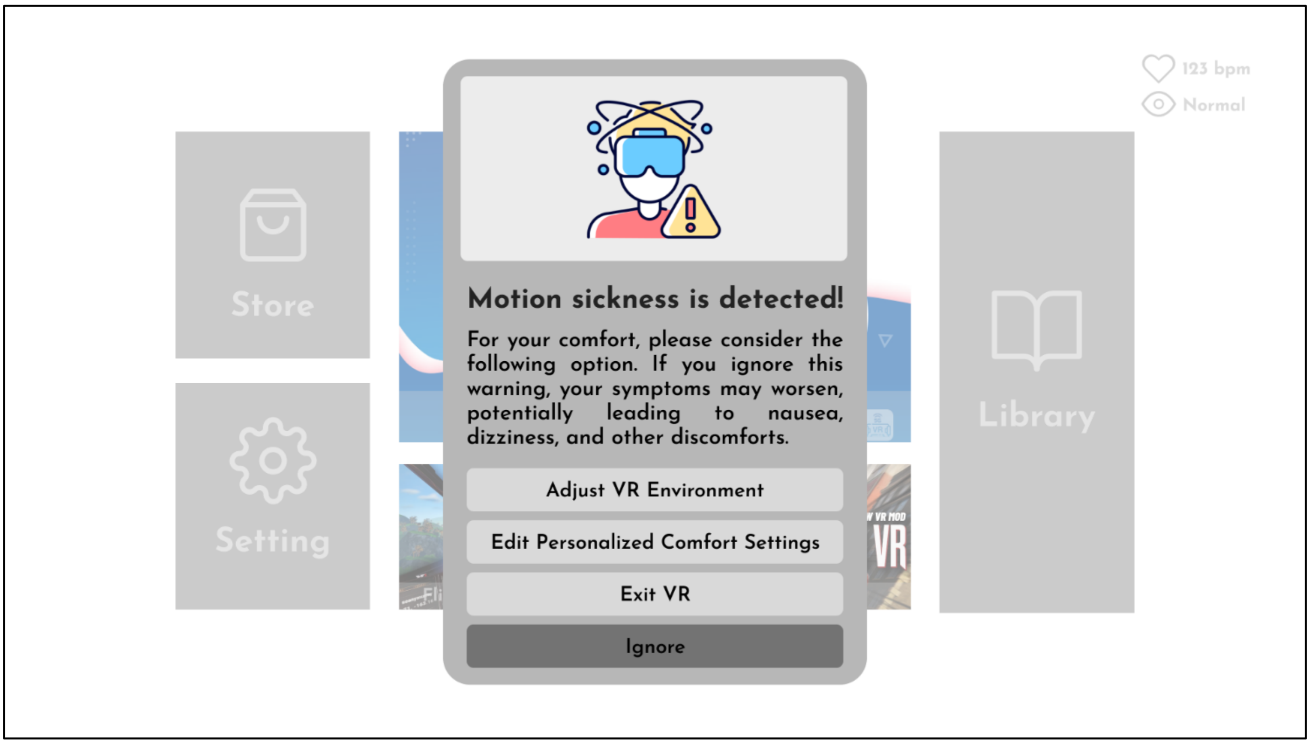


Figure 3.30: Motion Sickness Detected

Figure 3.30 demonstrates that if motion sickness is detected, a pop-up message will be displayed to inform users. They may choose to adjust the VR environment using adaptive algorithms, edit their personalized comfort settings, exit VR or ignore this message.

Figure 3.31: Adjusting VR Environment

As shown in Figure 3.31, once users clicked on "Adjust VR Environment", a pop-up message will notify the user that the system is adjusting the VR environment.

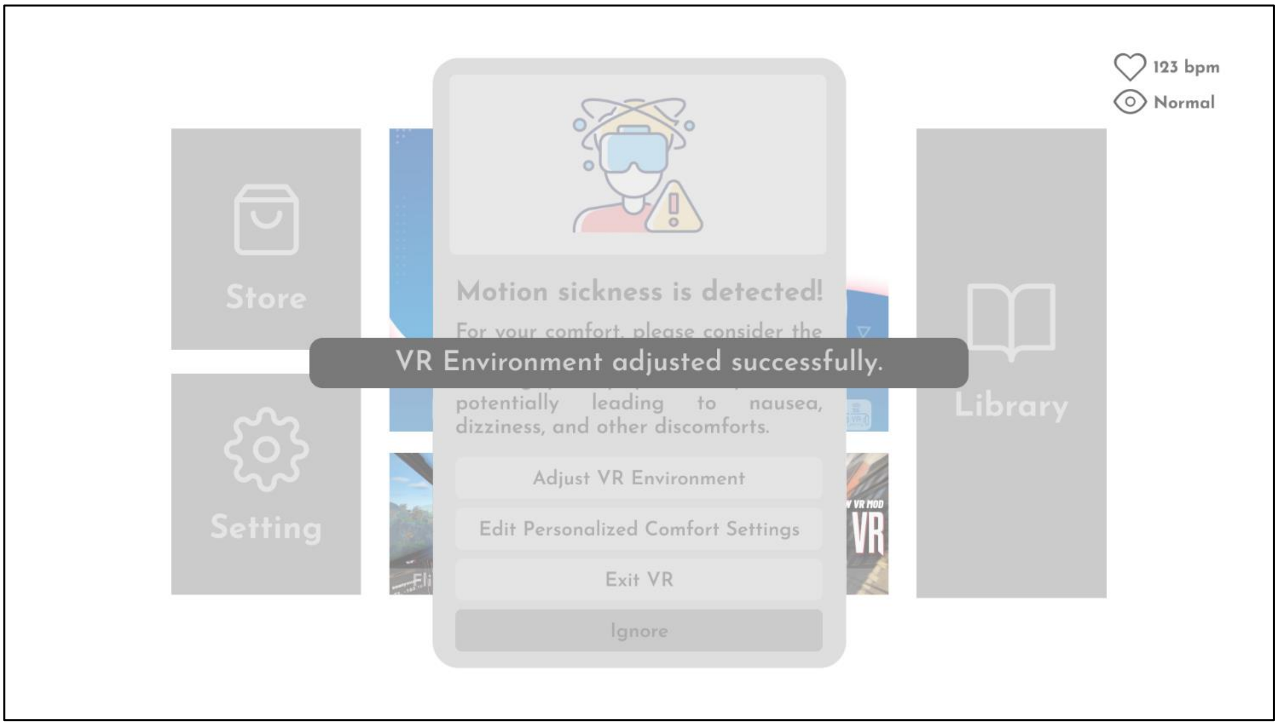


Figure 3.32: Adjust VR Environment Successfully

Figure 3.32 shows that adjustment on VR environment is successful. A pop-up message will appear to inform users that VR environment has adjusted.

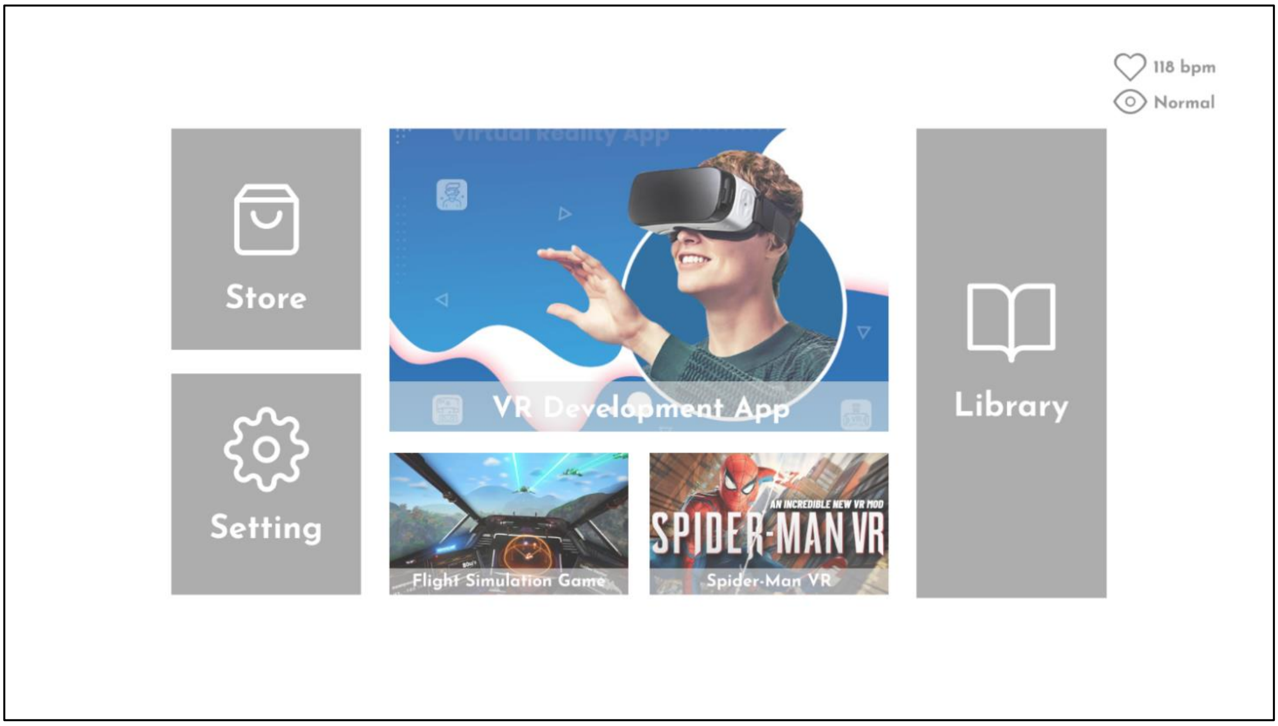


Figure 3.33: Adjusted VR Environment

Figure 3.33 shows the adjusted VR environment.

Pilot Test

Pilot test is conducted before usability testing. The objective of running pilot test is to fine-tine the usability testing process and identify any potential issues that may occur in the usability testing process (Schade, 2015). To achieve this, we have conducted two pilot tests using digital mock-up within our team. The participants are Chong Jing Ying and Tan Hui Xin. Table 3.3 shows the details of pilot tests:

Table 3.3: Participants and Results of Pilot Test

	Chong Jing Ying	Tan Hui Xin
Methodology	The participant was instructed to perform tasks with our digital mock-up. The participants were advised to try and break the testing process to find any errors that could occur during the testing phase.	
Testing Results	Overall, the testing process unfolded seamlessly, which allowed us to effectively convey the functionalities and features of ACSVR.	The process went seamlessly but found out that the briefing session before testing could be improved to let participants more aware on what and how should they perform the tasks.

The results showed that we achieved our goal of successfully showcasing the functionalities and features of ACSVR. However, we have improved the briefing session before testing to ensure they understand how the tasks should be performed.

Usability Testing

Quantitative Usability Testing

For this section, we have used the Usable, Satisfying, Easy (USE) scorecard as it gives an easy way for our participants to rate the usability of ACSVR. There are 4 participants involved in this testing. The USE scorecard has 3 sections, regarding usability, how satisfying it is to use, and how easy our product can be used, each having a range of scores from –2 to 2 and 4 questions each for each section.

The scoring standard is as below:

<0 Major flaw	0 – 2 Problem	3 – 5 Good	6 – 8 Excellent

The results ranged mostly from good to excellent across all 4 scorecards. Table 3.4, 3.5 and 3.6 displays the scores obtained in each section from 4 participants:

Table 3.4: Results of Context: Harmonize with User's Contexts of Use

	The feature adapts to user goals in the intended contexts of use.	The feature sustains the stress of the setting.	The feature syncs with the user's VAK limitations (visual, auditory, kinaesthetic).	The user will be able to operate the feature in varying attention deficit or altered states.	Total
User 1	2	2	0	1	5
User 2	1	2	1	1	5
User 3	2	1	1	2	6
User 4	2	2	0	1	5

Table 3.5: Results of Error: Prevent, Cushion and Reverse User Errors

	The feature prevents users from making	The feature provides a cushion when a potentially	Icons and visual elements (hard / soft key) require no interpretation	The user is able to easily reverse or continue their task	Total

	errors whenever possible.	serious error is about to be made.	past a few seconds.	without any problem-solving.	
User 1	2	2	2	2	8
User 2	1	1	2	1	5
User 3	1	2	2	2	8
User 4	1	0	2	2	5

Table 3.6: Results of Interaction: Build Intuitiveness in by Removing Understanding

	The feature requires no interpretation—it will offer an affordance for use.	The user can easily find what to do next.	The feature requires no understanding, knowledge, or any prior background or information.	The user can perform tasks successfully without help, training, or discovery time.	Total
User 1	2	2	1	2	7
User 2	1	2	2	1	6
User 3	1	2	1	2	6
User 4	2	2	2	2	8

In short, all the functionalities and features of ACSVR can be said to be intuitive for the most parts.

Qualitative Usability Testing

In UI/UX design, usability testing is key for checking how well a digital product works and how easy it is to use. Qualitative usability testing focuses on users' personal experiences to gather detailed insights. These insights help identify problems and suggest how to make improvements. This type of testing is valuable because it helps us understand not only what users do but also why they do it, giving us a clearer picture of their behaviours, likes, and difficulties.

In the qualitative phase of our usability testing, we have also used USE scorecard to evaluate ACSVR. However, for qualitative usability testing, we are more focused on detailed observations and open-ended feedback involving three randomly selected individuals. These participants directly interacted with the application we are studying. Through this approach, we were able to capture their specific interactions and firsthand reactions while navigating the interface. The insights gained from this process are crucial for guiding iterative refinements, ensuring that the application is intuitive and aligns well with user expectations and needs.

This section of the report will outline the testing procedure, summarize the participants' details, detail the observed interactions, and discuss the implications of the findings for ongoing UI/UX development.

Qualitative Usability Testing 1:

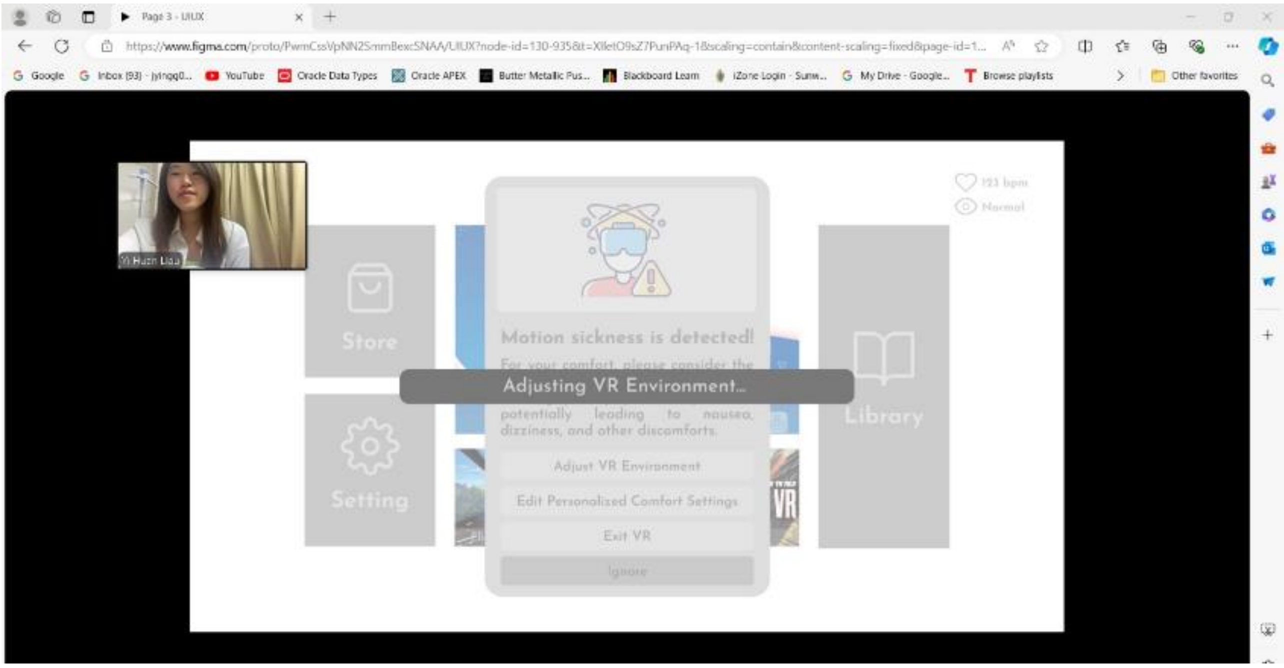


Figure 3.34: Qualitative Usability Testing 1

Table 3.7 shows the participant details and testing results for qualitative usability testing 1.

Table 3.7: Participant Details and Testing Results for Qualitative Usability Testing 1

Name	Liau Yi Huan
Age	22
Environment	Virtual Zoom meeting room
Procedure	Participant was required to engage with each functionality of our application to identify any issues she encountered. Subsequently, we systematically gathered observational data and feedback to evaluate her experience.

Duration to finish task	4
No. of confusions	1
No. of errors	0
Scorecard	Section A : 5 Section B : 6 Section C : 5
Feedback	The user found the system to be extremely user-friendly, noting that the interface was intuitive and easy to navigate. She was able to utilize all the features seamlessly, without encountering any issues. As a virtual reality user who occasionally experiences motion sickness, she found our adaptive comfort system particularly impressive. She commented that the personalized comfort settings, which allow users to adjust their preferences and set the heart rate monitor to a specific bpm range, were highly appreciated. The ability to enable eye-tracking and set heart rate monitor ranges was particularly useful. Additionally, she suggested the integration of voice control to further enhance the convenience and usability of the system. Although this is currently just a digital mock-up, she would be happy if a real system could be developed using this design.

Qualitative Usability Testing 2:

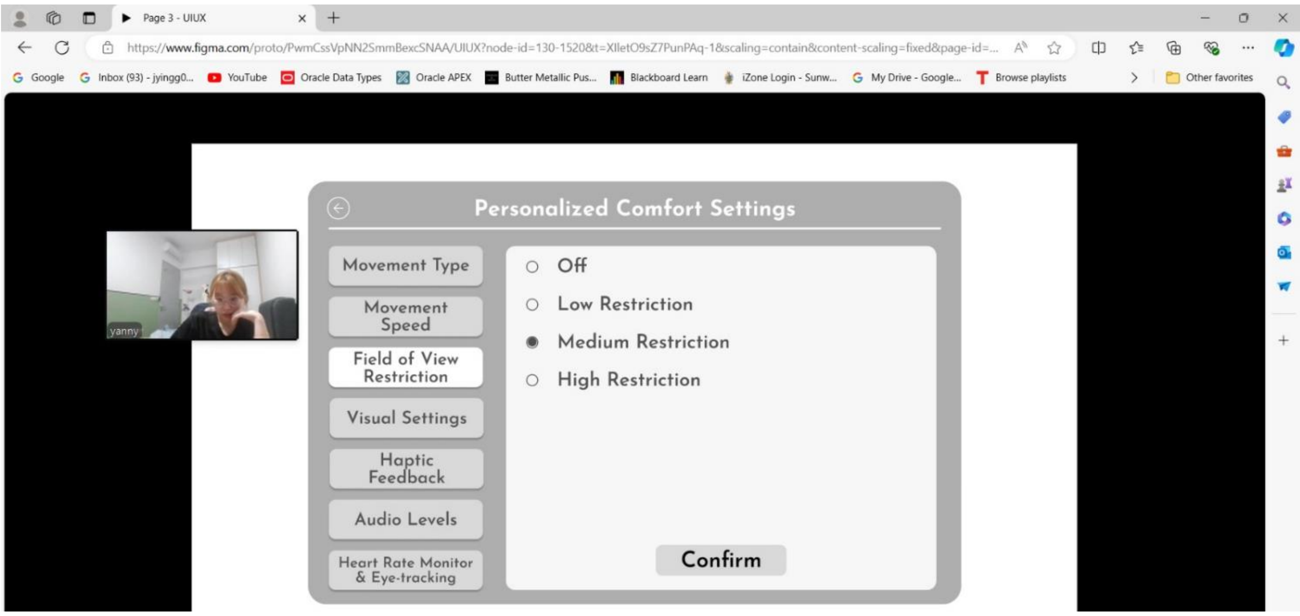


Figure 3.35: Qualitative Usability Testing 2

Table 3.8 shows the participant and testing results for qualitative usability testing 2.

Table 3.8: Participant Details and Testing Results for Qualitative Usability Testing 2

Name	Yanny Lim Yuan
Age	22
Environment	Virtual Zoom meeting room
Procedure	Participant was tasked with exploring every feature of our application to pinpoint any problems she faced. We then methodically collected observational data and feedback to analyze her user experience.
Duration to finish task	5
No. of confusions	1
No. of errors	0
Scorecard	Section A : 5 Section B : 5 Section C : 7
Feedback	The user found the system to be straightforward and easy to use, appreciating the clear layout and the functionality of features like the eye-tracking and

	heart rate monitor. She mentioned that while the interface is intuitive, the system could benefit from additional features. The current functionalities are well-executed, but expanding the feature set could significantly enhance the user experience. She suggested considering more innovative functions to provide a richer, more engaging experience for users.

Qualitative Usability Testing 3:

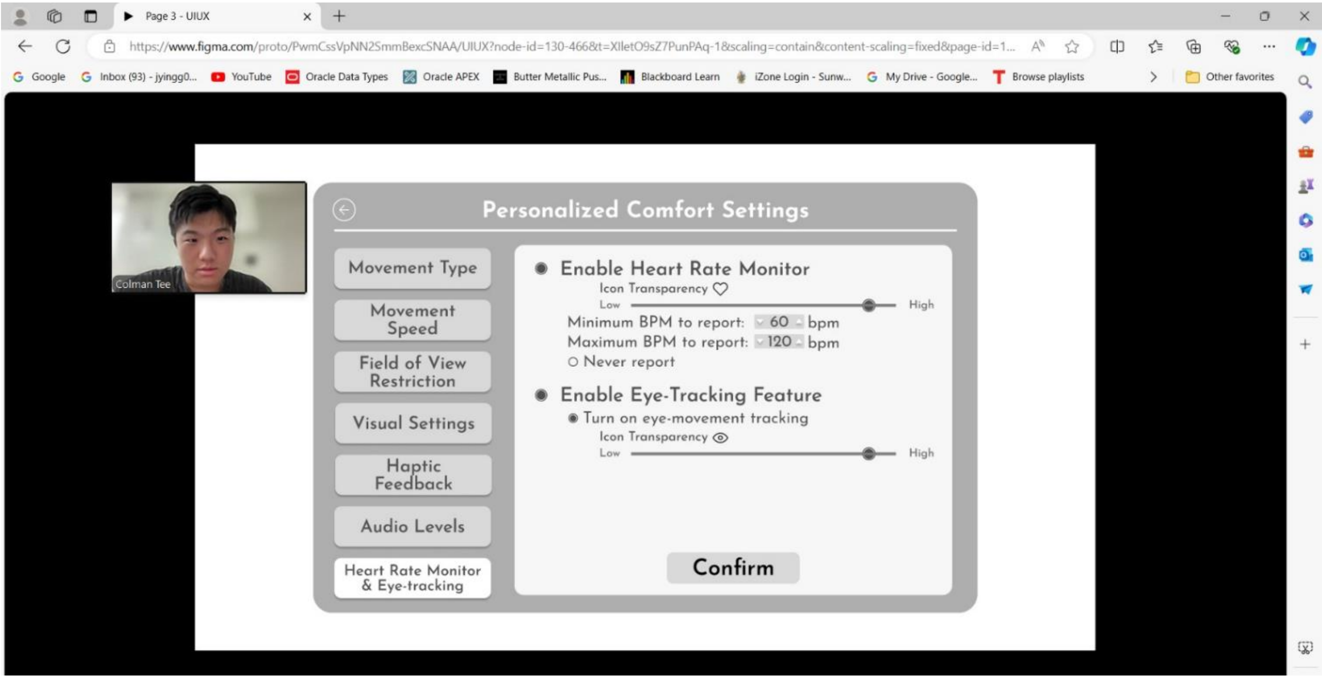


Figure 3.36: Qualitative Usability Testing 3

Table 3.9 shows the participant and testing results for qualitative usability testing 3.

Table 3.9: Participant Details and Testing Results for Qualitative Usability Testing 3

Name	Tee Jin Sheng
Age	21
Environment	Virtual Zoom meeting room
Procedure	Participant was tasked with exploring every feature of our application to pinpoint any problems he faced. We then methodically collected observational data and feedback to analyze his user experience.
Duration to finish task	5

No. of confusions	0
No. of errors	0
Scorecard	Section A : 6 Section B : 5 Section C : 7
Feedback	The user appreciated the intuitive design and ease of use of the system but suggested further enhancements for an optimal experience. He was particularly interested in the idea of customizable visual themes. The ability to change color schemes, background images, and even the layout of the user interface would greatly enhance personalization, allowing users to tailor the system to their preferences. This customization is crucial as it helps reduce visual fatigue, a common issue in virtual reality environments, thereby enhancing comfort and extending user sessions. Additionally, he recommended the implementation of guided tutorials. These tutorials would help new users familiarize themselves quickly with the system, ensuring they fully utilize all the features available.

Final Design

The final design of the Adaptive Comfort System for Virtual Reality (ACSVR) was refined through a series of usability testing, ensuring that it enhances the overall VR experience for motion sickness users. This section presents a detailed overview of the final design components and their functionalities, emphasizing how they contribute to a more comfortable and immersive VR experience.

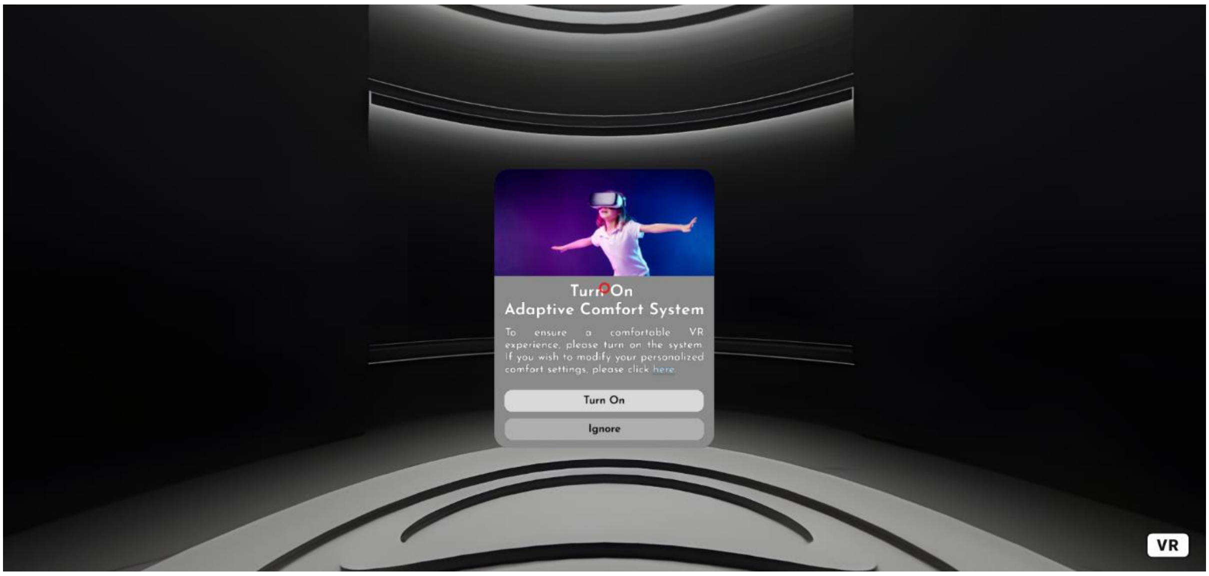


Figure 3.37: Set Up ACSVR

Figure 3.37 prompts the user to activate this system to ensure a comfortable VR experience, with options to "Turn On" or "Ignore," and an additional option to modify personalized comfort settings by clicking "here."

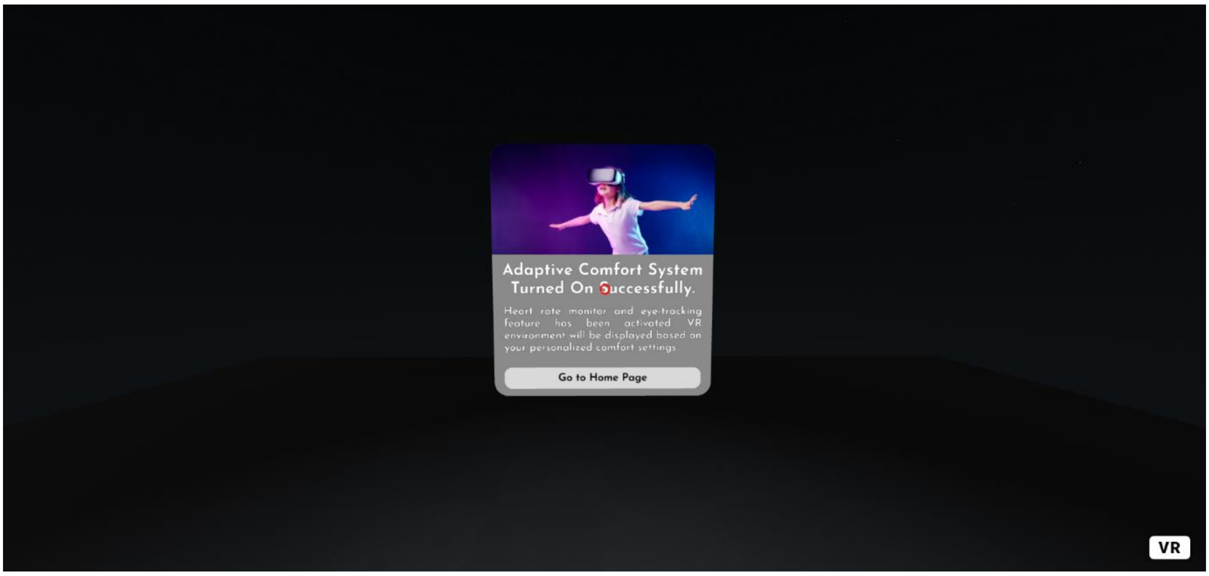


Figure 3.38: ACSVR Turned on Successfully

Figure 3.38 confirms the system has been successfully activated, noting that heart rate monitoring and eye-tracking features are now operational to adjust the VR environment based on these settings, with an option to "Go to Home Page.

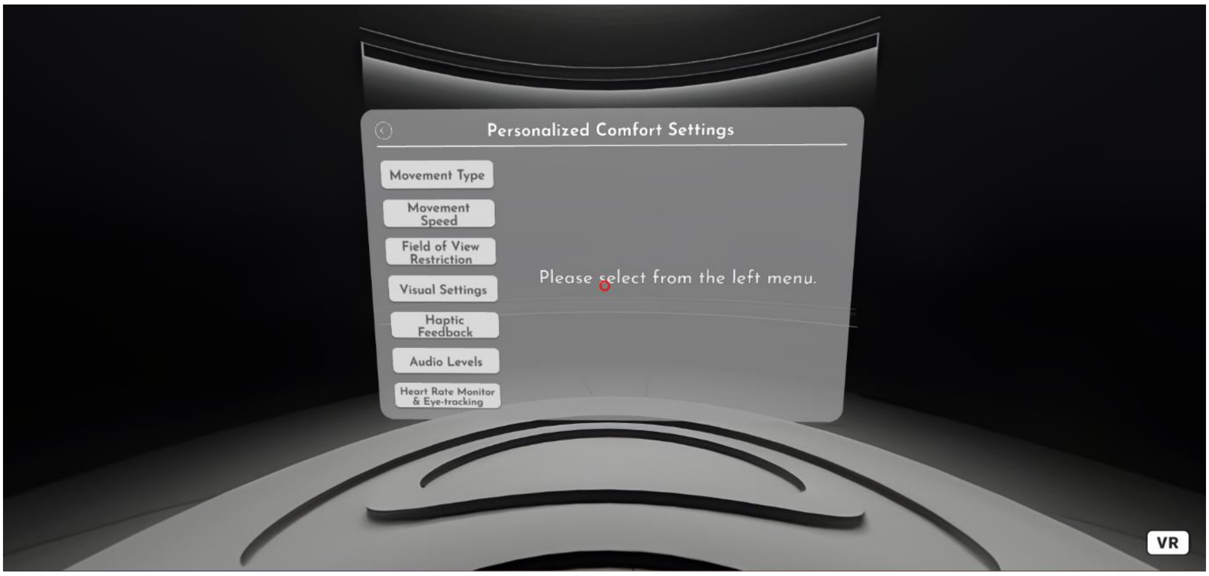


Figure 3.39:Personalized Comfort Settings

Figure 3.39 shows VR interface screens for "Personalized Comfort Settings" which is having lists options like Movement Type, Movement Speed, Field of View Restriction, Visual Settings, Haptic Feedback, Audio Levels, and Heart Rate Monitor & Eye-tracking.

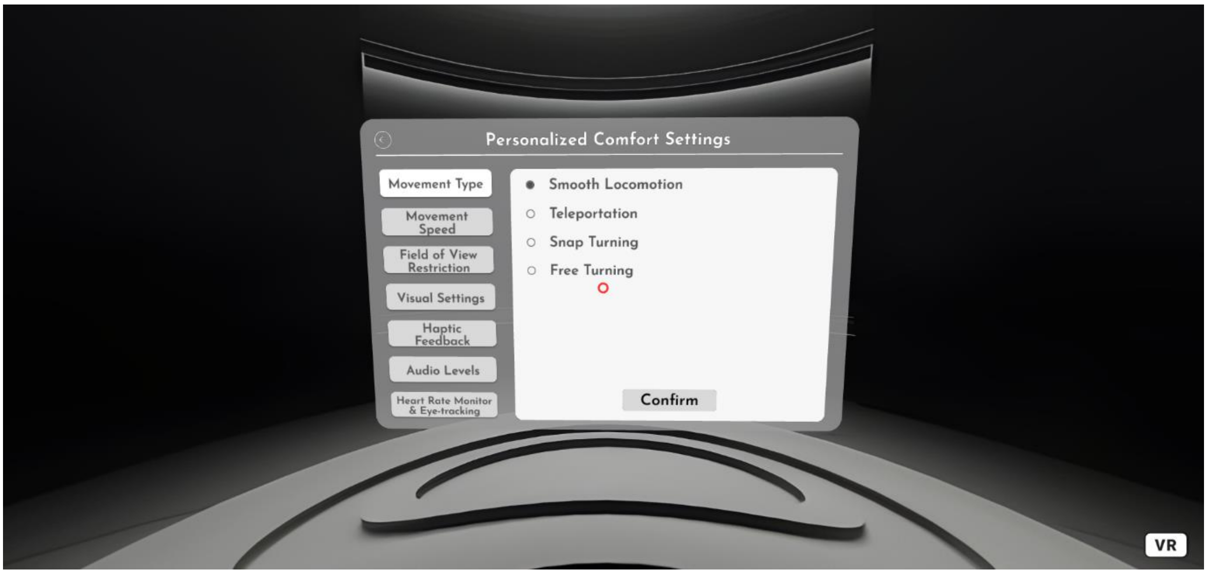


Figure 3.40: Movement Type Setting

Figure 3.40 focus on adjusting movement type, offering smooth locomotion, teleportation, snap turning, and free turning.

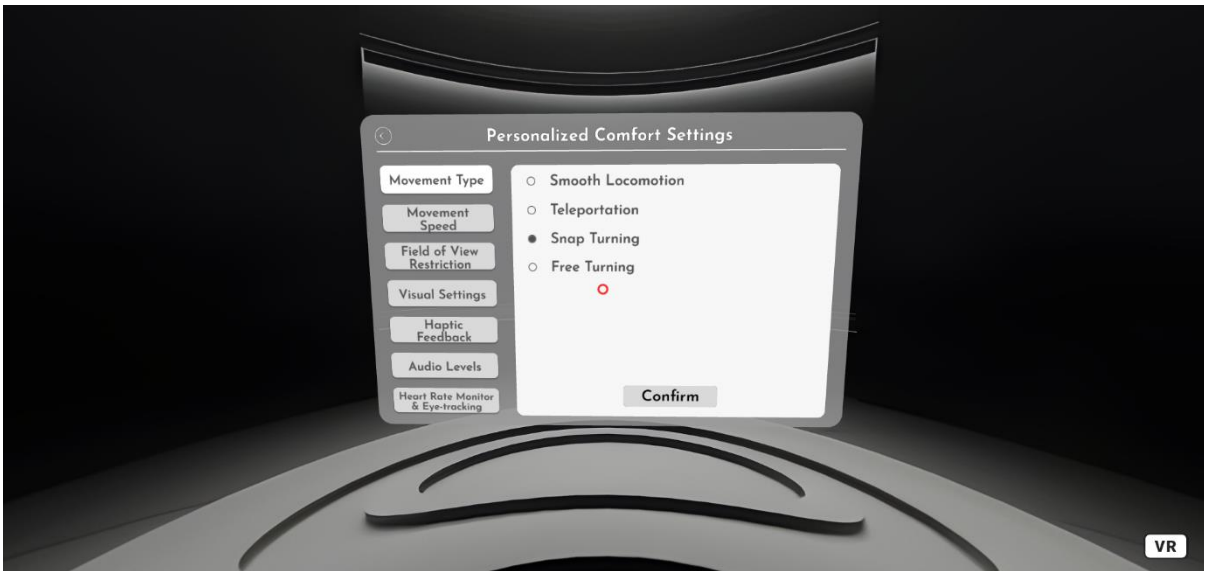


Figure 3.41: Modification of Movement Type Setting

Figure 3.41 shows that smooth locomotion is changed to snap turning.

Figure 3.42: Confirm Modification for Movement Type Setting

Figure 3.42 shows that user can click "Confirm" to finalize the selection.

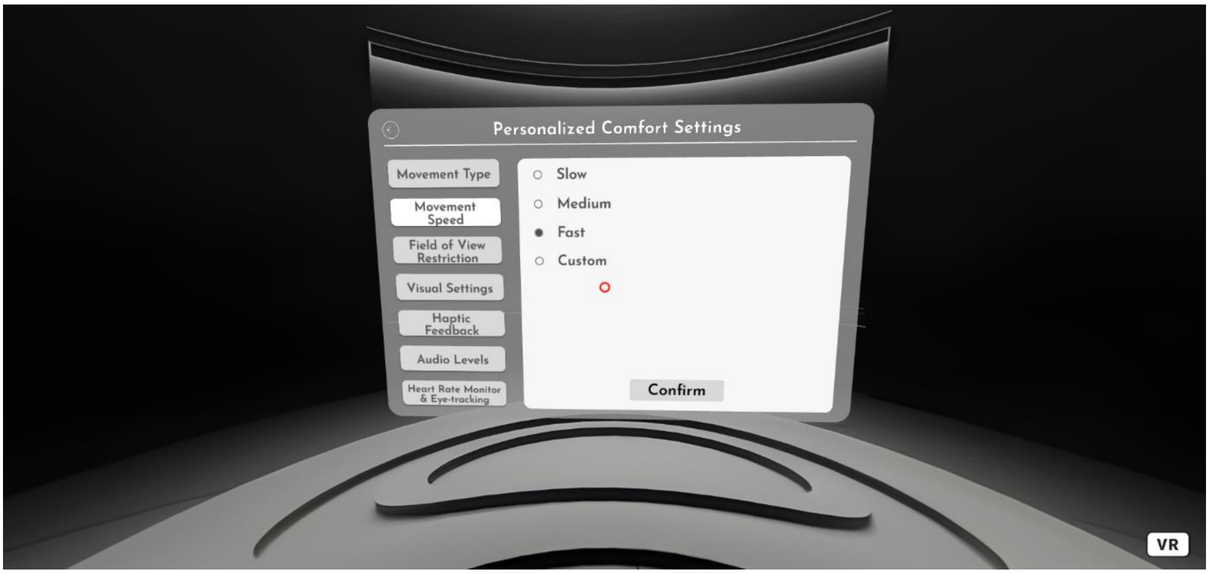


Figure 3.43: Movement Speed Setting

Figure 3.43 displays VR interface screens for adjusting movement speed which offers options for slow, medium, fast, and custom speeds.

Figure 3.44: Modification of Movement Speed Setting

Figure 3.44 shows the custom speed option with a slider to adjust the speed between slow and fast.

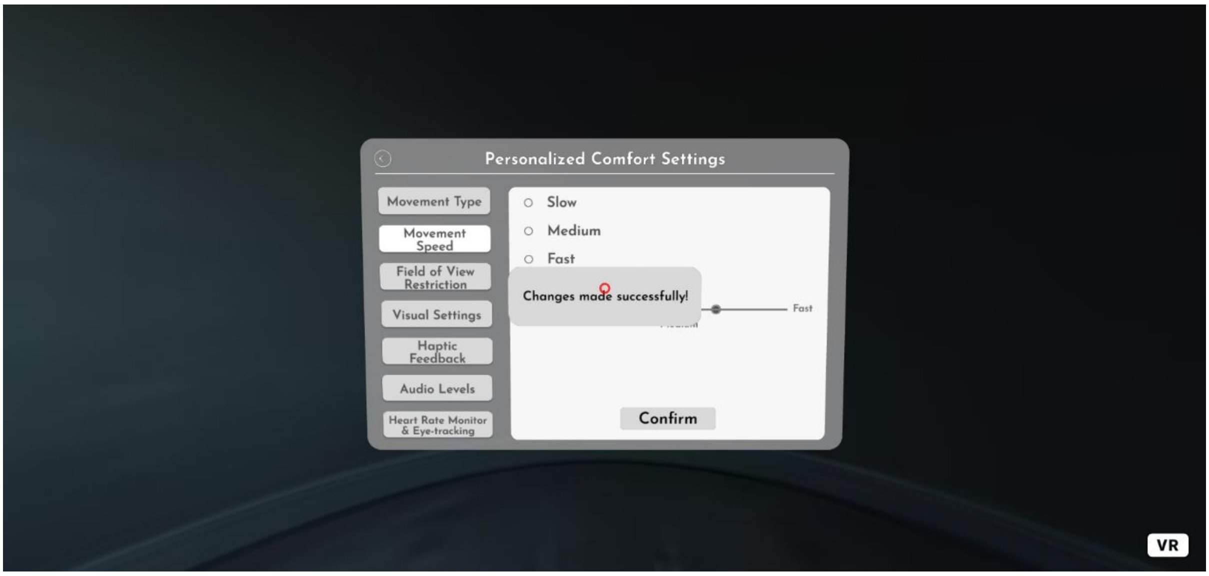


Figure 3.45: Confirm Modification for Movement Speed Setting

Figure 3.45 confirms that changes have been made successfully with the custom speed setting adjusted.

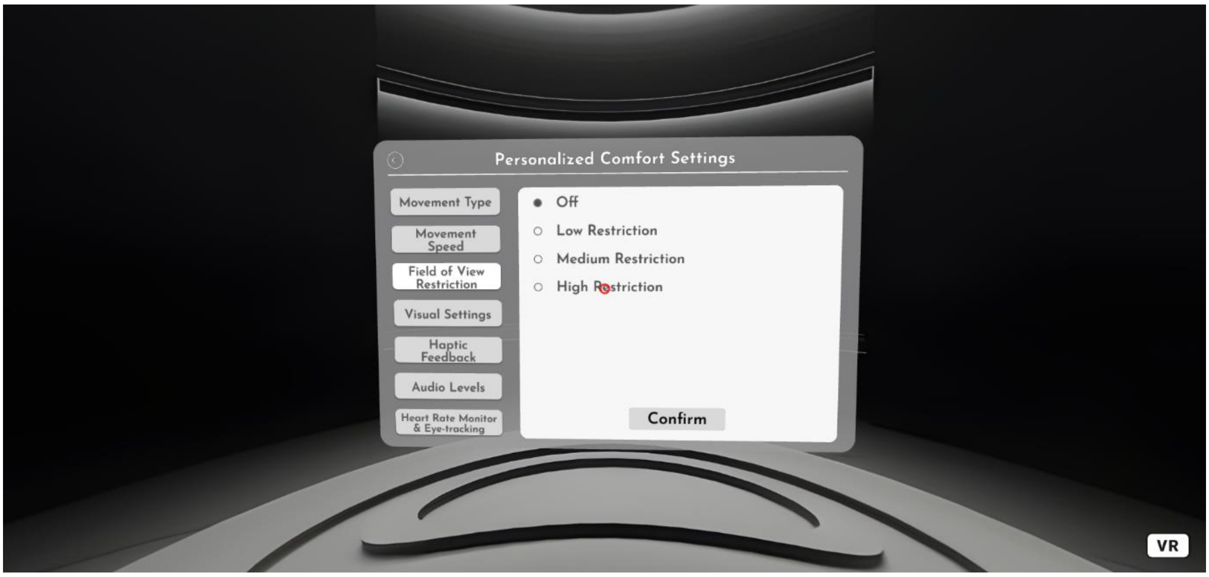


Figure 3.46: Field of View Restriction Setting

Figure 3.46 displays VR interface screens for adjusting FOV Restriction which offers options for off, low Restriction, medium restriction, and high restriction.

Figure 3.47: Modification of Field of View Restriction Setting

Figure 3.47 shows the user selecting Medium Restriction.

Figure 3.48: Confirm Modification for Field of View Restriction Setting

Figure 3.48 confirms that changes have been made successfully with the Medium Restriction setting selected.

Figure 3.49: Visual Setting

Figure 3.49 displays visual settings which allows users to adjust brightness, contrast, and colour settings (Red, Green, Blue) with sliders.

Figure 3.50: Decreasing Contrast in Visual Setting

Figure 3.50 shows the changes of decreasing contrast in the VR environment.

Figure 3.51: Modification of Visual Setting

Figure 3.51 shows the settings reverted to the default, with the user making new adjustments.

Figure 3.52: Confirm Modification for Visual Setting

Figure 3.52 shows that changes have been made successfully by clicking “Confirm” button.

Figure 3.53: Haptic Feedback Setting

Figure 3.53 displays VR interface screens for adjusting haptic feedback which allows users to choose between off, low Intensity, medium Intensity, high Intensity, and custom settings.

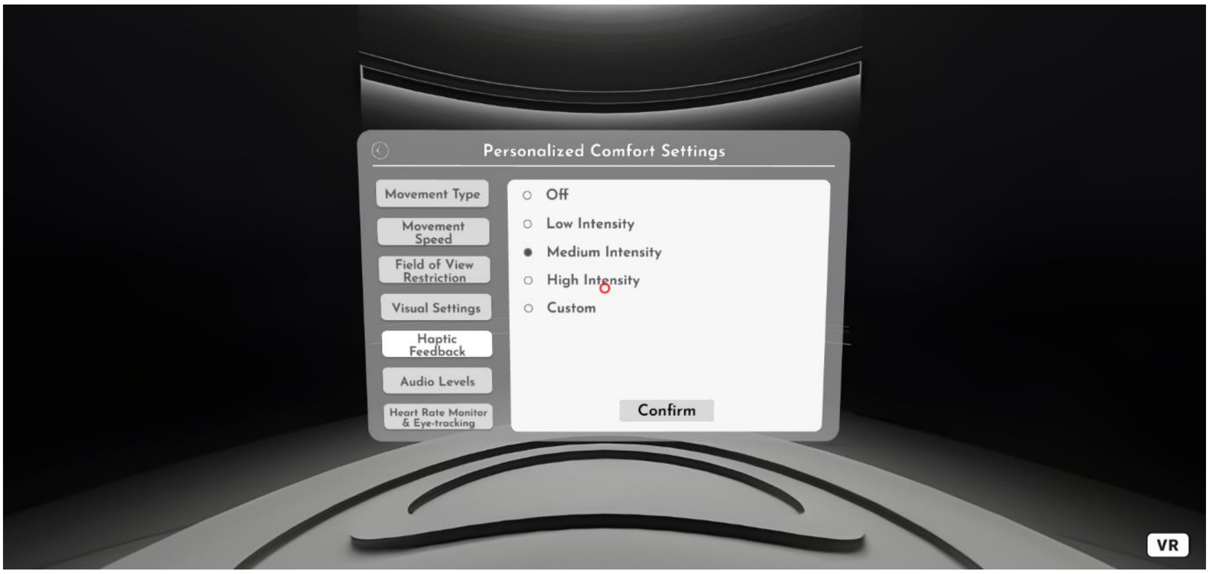


Figure 3.54: Modification of Haptic Feedback Setting

Figure 3.54 shows the user selecting high intensity.

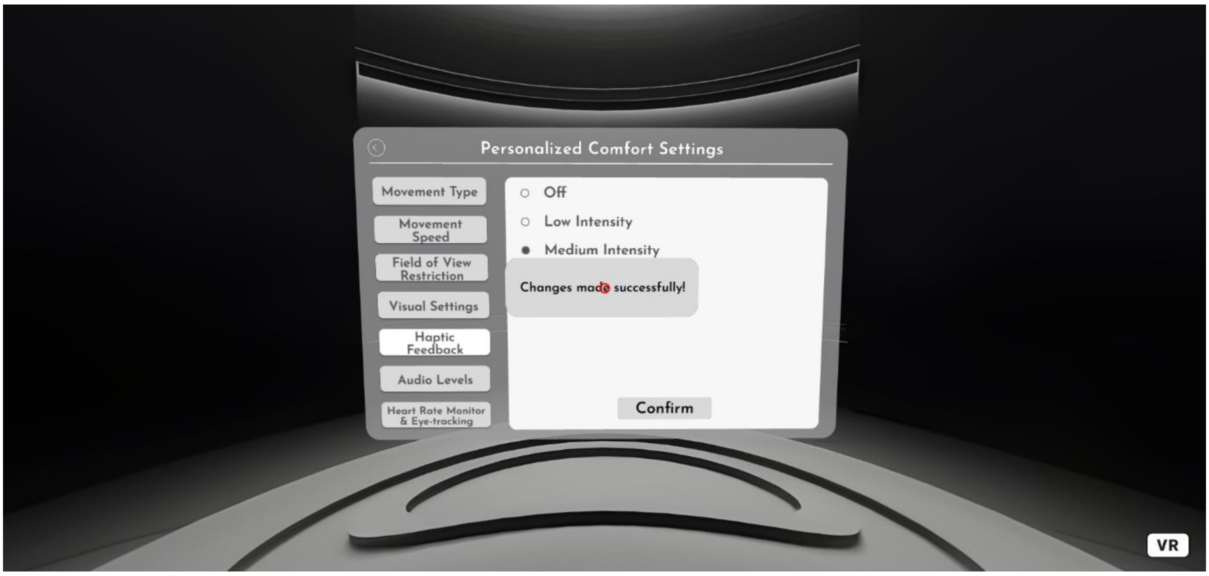


Figure 3.55: Confirm Modification for Haptic Feedback Setting

Figure 3.55 confirms that changes have been made successfully with the medium intensity setting selected by clicking "Confirm."

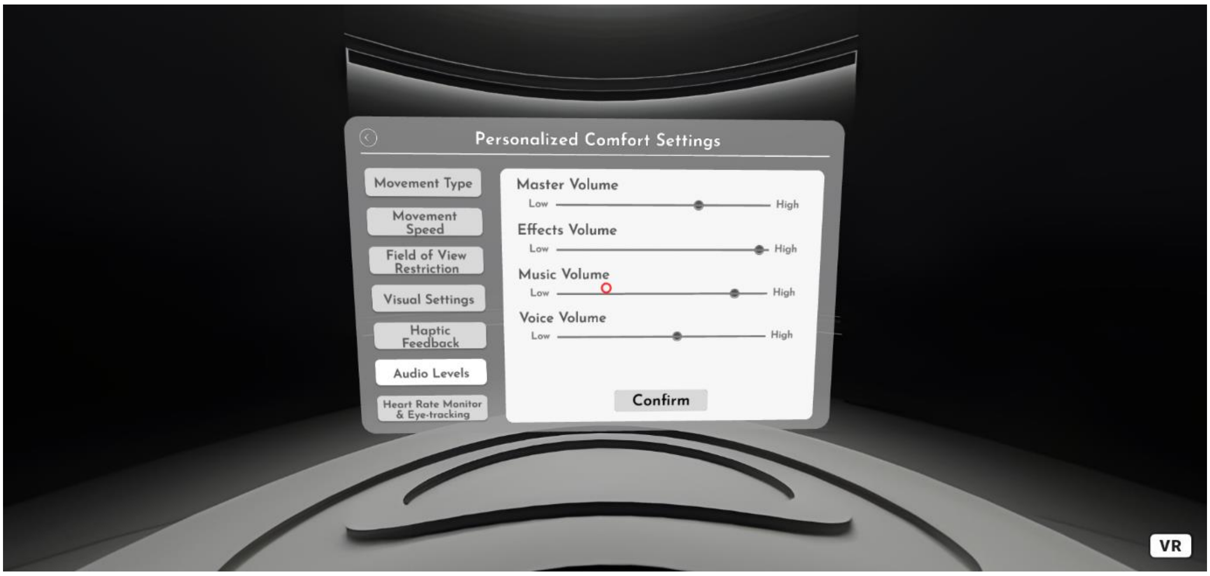


Figure 3.56: Audio Level Setting

Figure 3.56 displays VR interface screens for adjusting audio levels which allows users to adjust master volume, effects volume, music volume, and voice volume with sliders.

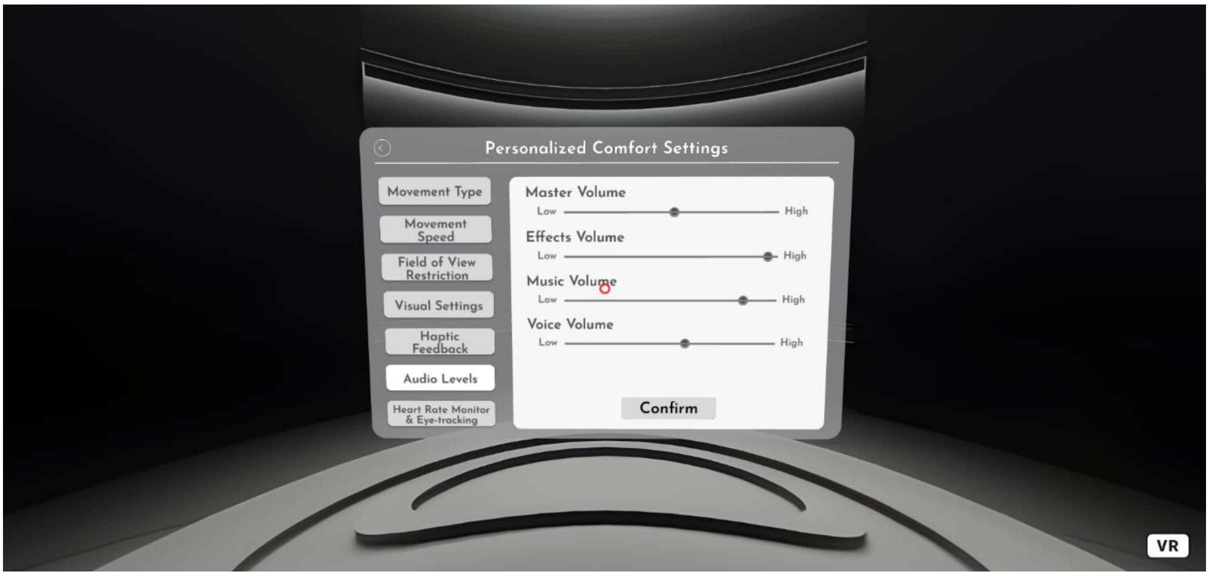


Figure 3.57: Modification on Audio Level Setting

Figure 3.57 shows the same settings, with adjustments being made to the master volume.

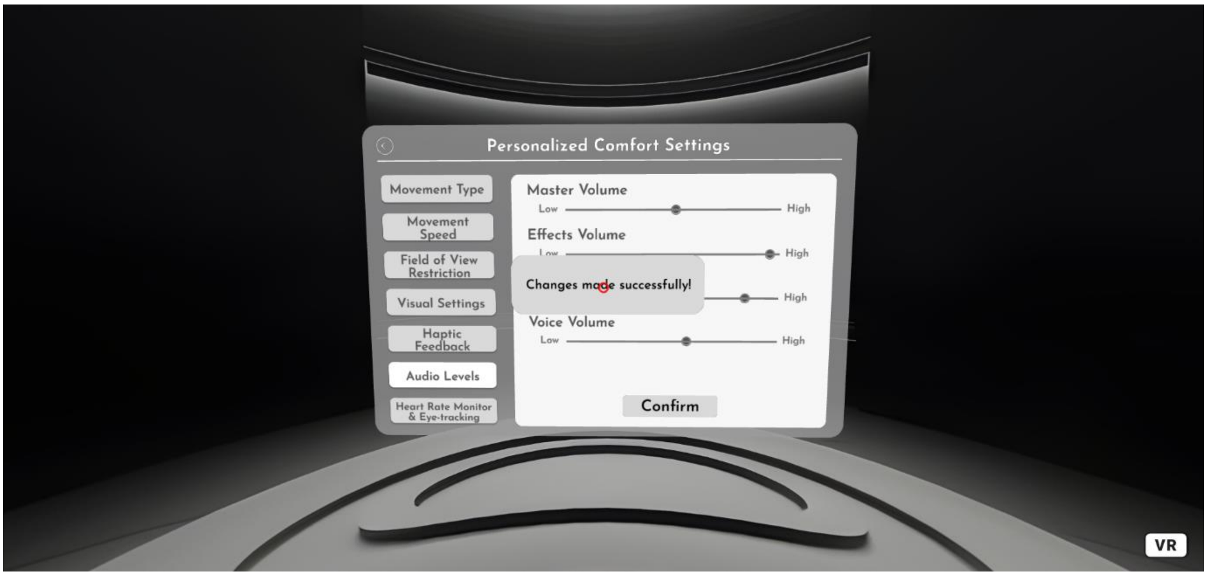


Figure 3.58: Confirm Modification for Audio Levels Setting

Figure 3.58 confirms that changes have been made successfully with the new audio levels by clicking "Confirm".

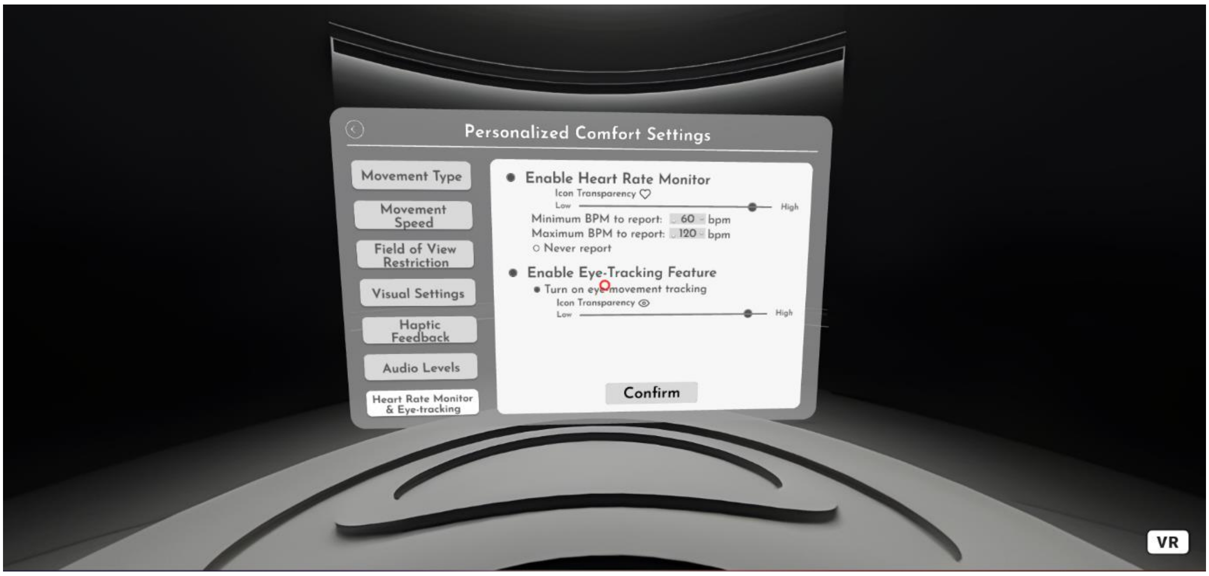


Figure 3.59: Heart Rate Monitor and Eye-tracking Feature Setting

Figure 3.59 shows the settings for heart rate monitor and eye-tracking feature. Users may choose to enable or disable the heart rate monitor and eye-tracking feature. Besides that, they can adjust the icon's transparency for both. For heart rate monitor, they can set the minimum and maximum bpm to prompt warning messages.

Figure 3.60: Modification of Heart Rate Monitor and Eye-Tracking Feature Setting

Figure 3.60 shows the modification on icon's transparency for eye-tracking feature.

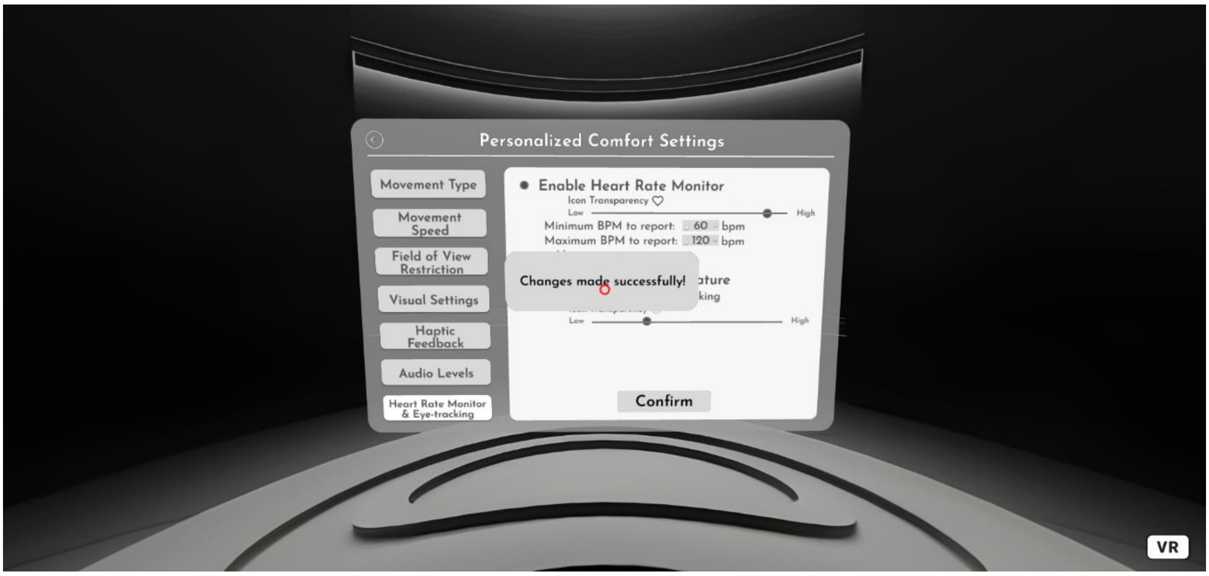


Figure 3.61: Confirm Modification for Heart Rate Monitor and Eye-tracking Feature Setting

Figure 3.61 confirms that changes have been made successfully by clicking "Confirm."

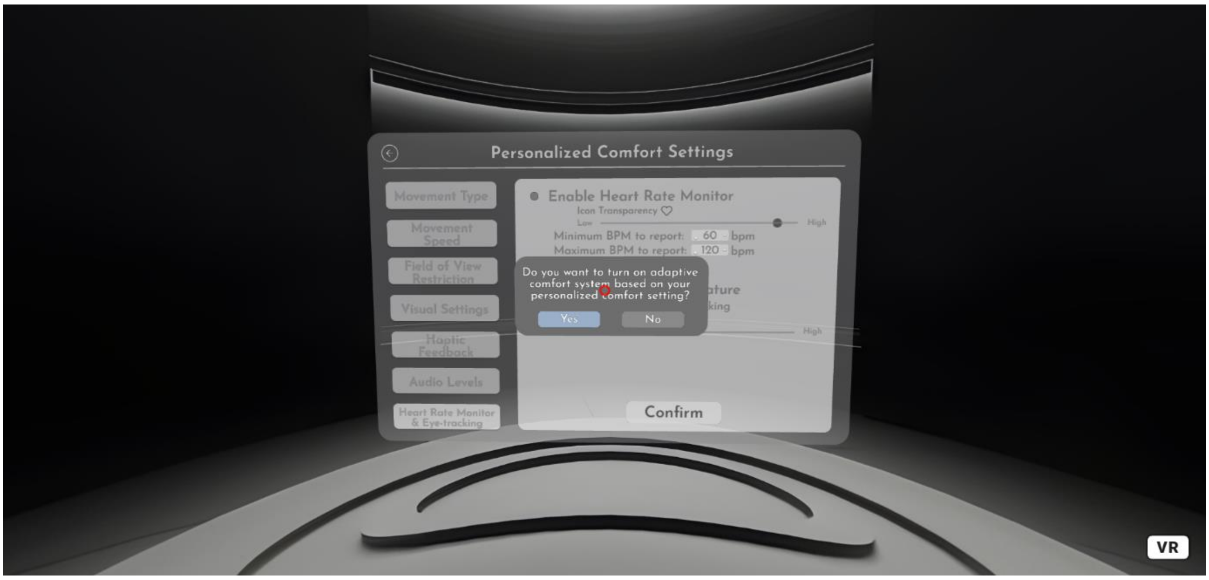


Figure 3.62: Selection of Turning on ACVSR

Figure 3.62 displays VR interface screens confirming the activation of the ACVSR which prompts the user with a message asking, "Do you want to turn on the adaptive comfort system based on your personalized comfort settings?" with options to select "Yes" or "No."

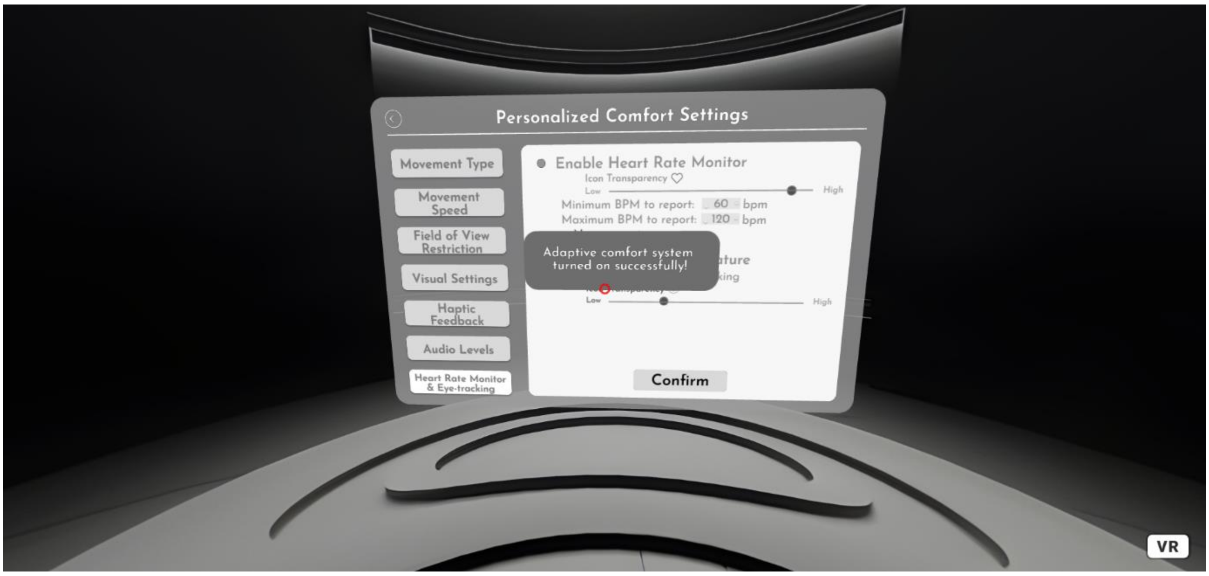


Figure 3.63: ACSVR Turned on Successfully

Figure 3.63 shows that ACVSR has been turned on successfully.

Figure 3.64: Home Page

Figure 3.64 shows that after pop-up message shown, users will be directed to their home page. Real-time heart rate and eye movement are shown on the top-right side of the home page.

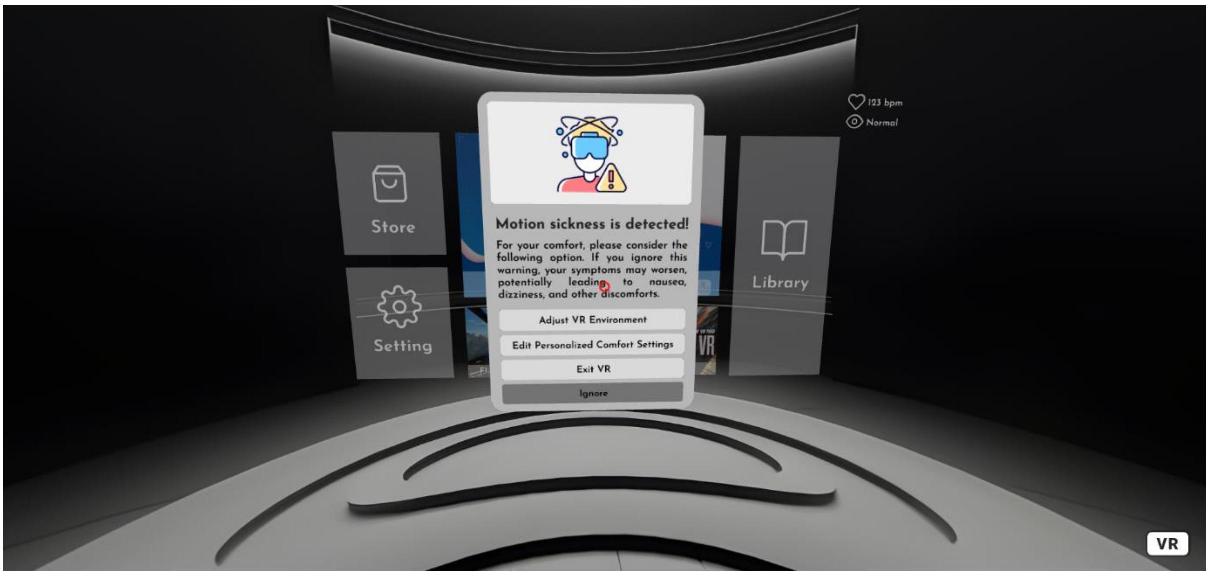


Figure 3.65: Motion Sickness Detected

Figure 3.65 shows that upon detecting motion sickness, a warning appears with options to adjust VR environment, edit personalized comfort settings, exit VR, or ignore.

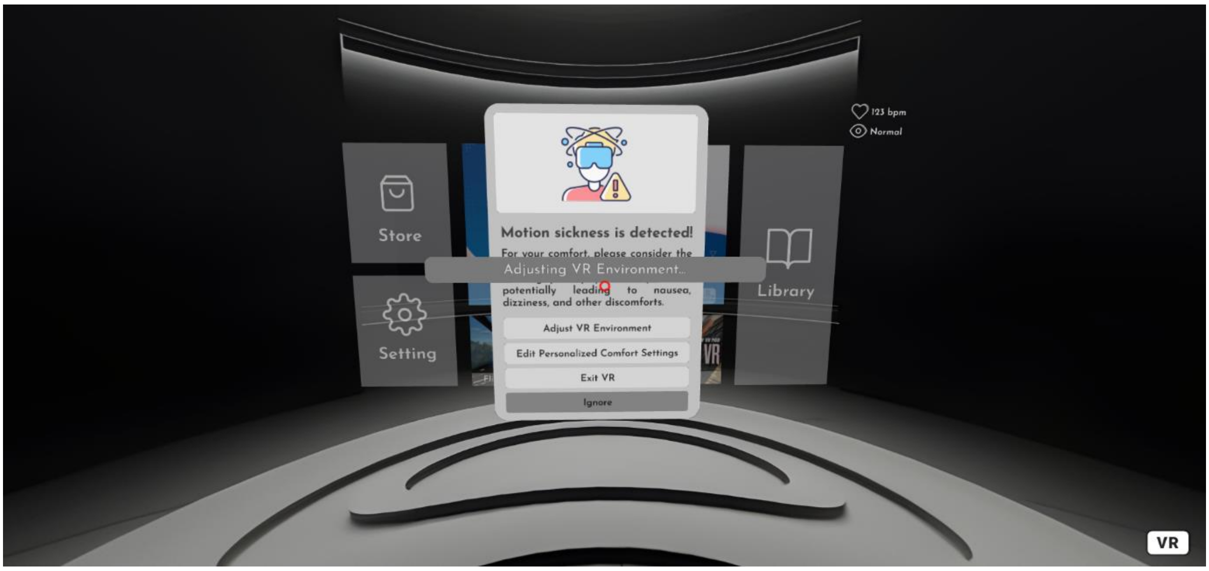


Figure 3.66: Adjusting VR Environment

Once users clicked on “Adjust VR Environment”, a pop-up message will notify the user that the system is adjusting the VR environment which is shown in Figure 3.66.

Figure 3.67: VR Environment Adjusted Successfully

Figure 3.67 shows that after selecting an adjustment, a confirmation message states the VR environment has been adjusted successfully.

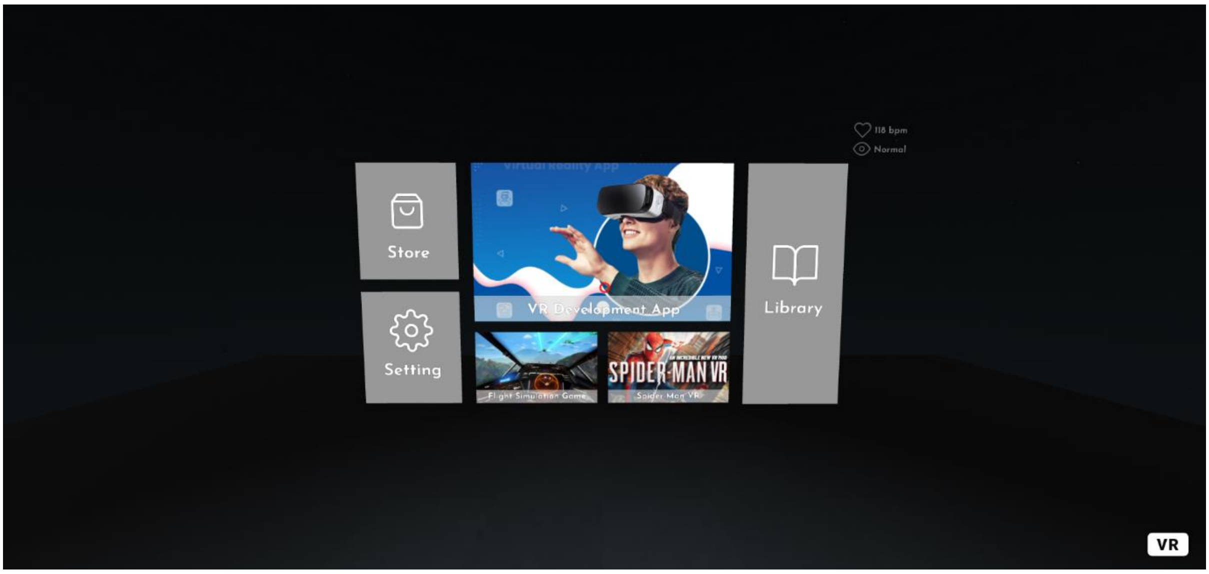


Figure 3.68: Adjusted VR Environment

Figure 3.68 returns to the adjusted home page.

Summary of Milestone 3

In this final milestone, we focused on prototyping and iteration processes based on heuristic evaluations and usability testing to refine the system's design and functionality.

The heuristic evaluations conducted with groups UX-2-1 and UX-4-2 provided crucial insights into areas requiring improvement. Necessary changes are made when developing the digital mock-ups. The mock-ups demonstrated various functionalities, including setting adjustments for movement type, speed, field of view restriction, visual settings, haptic feedback, audio levels, and heart rate monitoring.

Before conducting usability testing, pilot testing revealed that while the digital mock-ups effectively conveyed the system’s features, improvements were needed in the briefing session to enhance participants' understanding of the tasks.

The quantitative usability testing, using the Usable, Satisfying, Easy (USE) scorecard, provided a detailed assessment of the system’s usability. The results indicated that the ACSVR system is generally perceived as good to excellent in terms of usability, error prevention, and interaction intuitiveness. These positive outcomes validated the effectiveness of the system's design in addressing motion sickness in VR environments.

Qualitative usability testing further reinforced the system's strengths and highlighted areas for potential enhancement. Feedback from participants suggested the integration of additional features like voice control and customizable visual themes, which could further improve user comfort and experience.

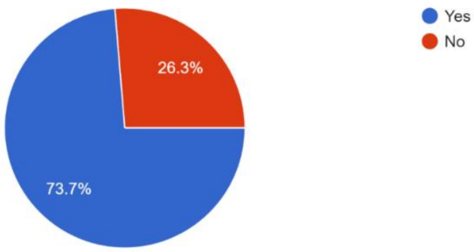
At the end of milestone 3, we successfully developed ACSVR which represents a significant advancement in addressing motion sickness within VR environments. Through a structured approach encompassing research and analysis, ideation and conceptualization, prototyping and iteration, the project has achieved its goal.

Appendices

Appendix 1: Google Form Survey Results

Have you ever experienced Virtual Reality (VR) before?

19 responses



Personal Information

What is your name?

14 responses

Thien Tze Yea

Muhammad Hafiz

Azlan Faiz

Alvin Goh

Lim Wei Shen

Kendra

Ng Xiao Wei

Thien Tze Lin

Priya Lakshmi

Eugene Lew

Voo Kah Lock

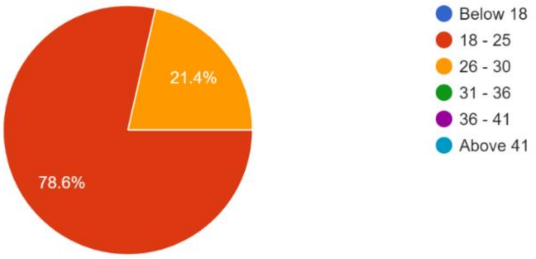
Allan Tan

Louis Ong

CHONG JING YING

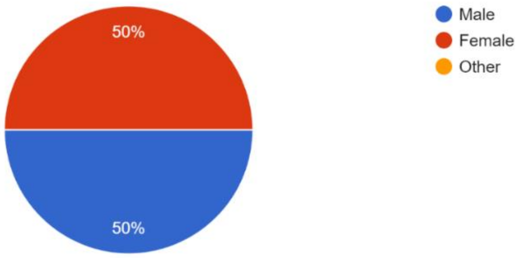
What is your age?

14 responses



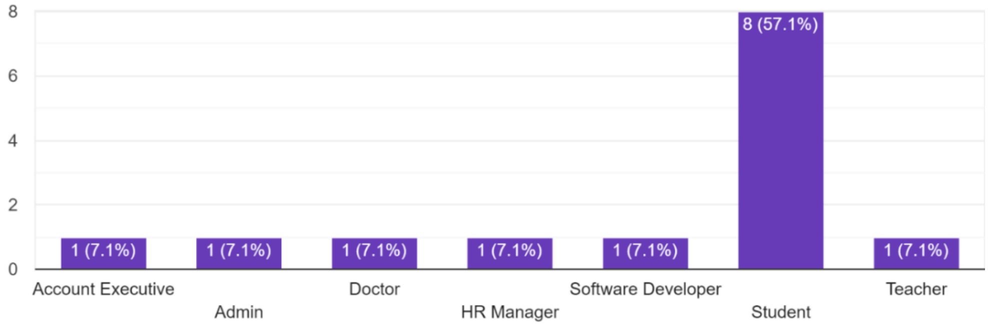
What is your gender?

14 responses



What is your occupation?

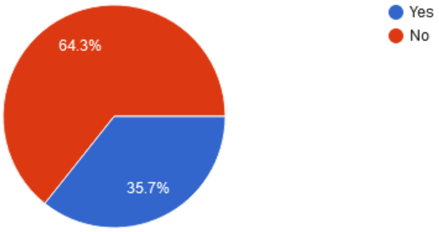
14 responses



Virtual Reality (VR) Experience

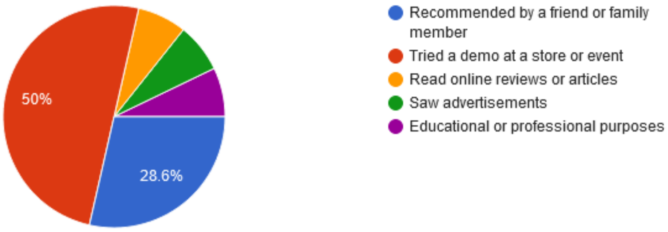
Do you own a VR device?

14 responses



How did you start your first VR experience?

14 responses



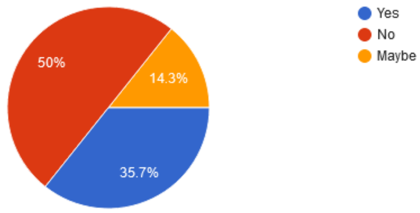
What was your first impression when using VR technology?

14 responses

- excited
- I felt like it has plenty of use, and i feel good after using it the first time
- It has a lot of potential especially to teach students.
- Immersive
- It is a very cool device, futuristic
- It was cool but Im not used to it
- It was very fun to try for the first time
- was really excited
- Very fun and looks like the future.
- Very good experience, I bought it afterwards
- sorry i forgot
- Good
- I don't like it
- Cool and interesting

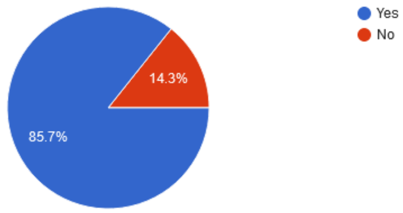
Was it hard to use VR technology for the first time? Copy

14 responses



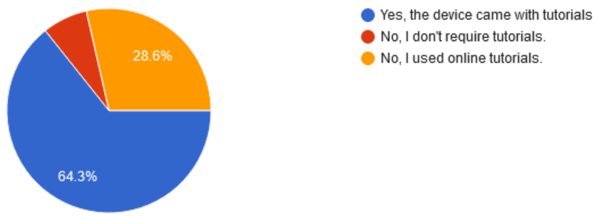
Was there any tutorials when you start using VR technology? Copy

14 responses



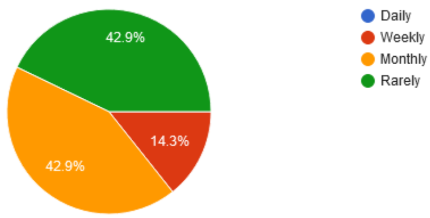
Did you used the provided tutorials? Copy

14 responses



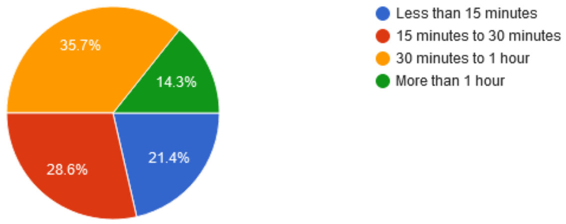
How often do you use VR technology? Copy

14 responses



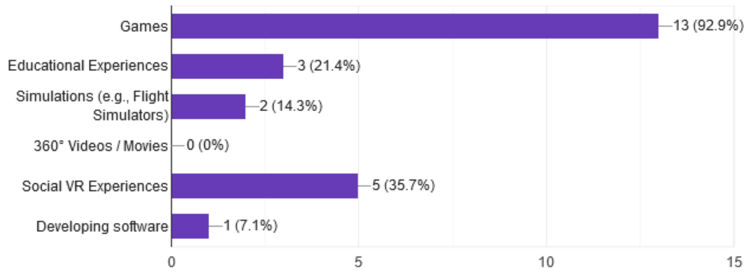
On average, how long do your VR sessions last?

14 responses



What types of VR content do you typically engage with? (More than one option can be selected)

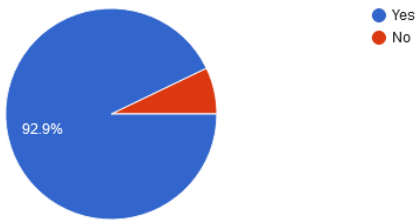
14 responses

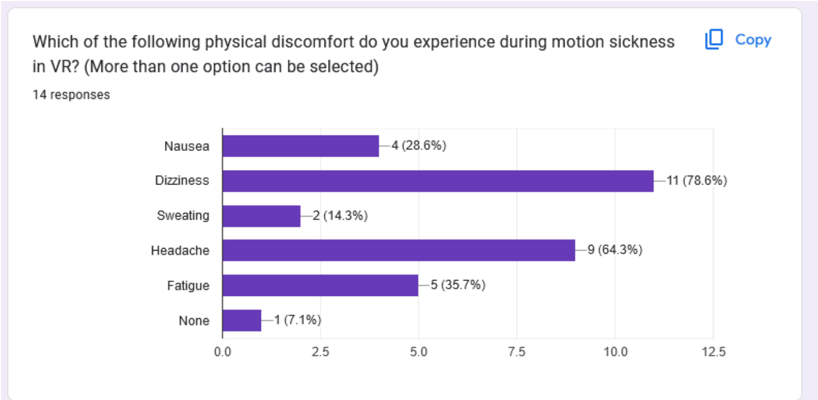


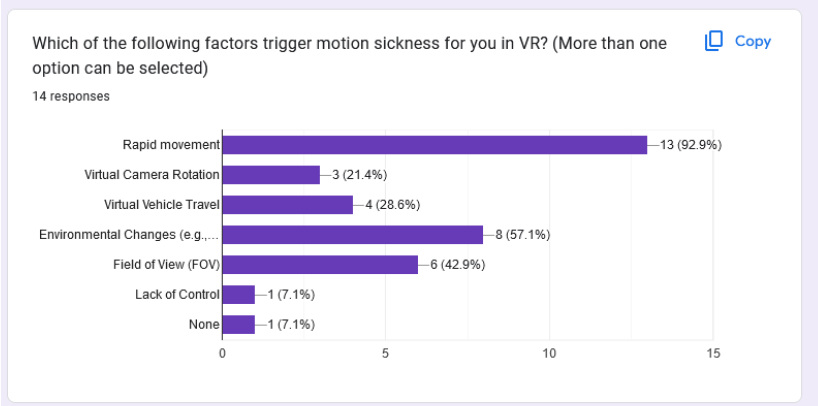
Motion Sickness in Virtual Reality (VR)

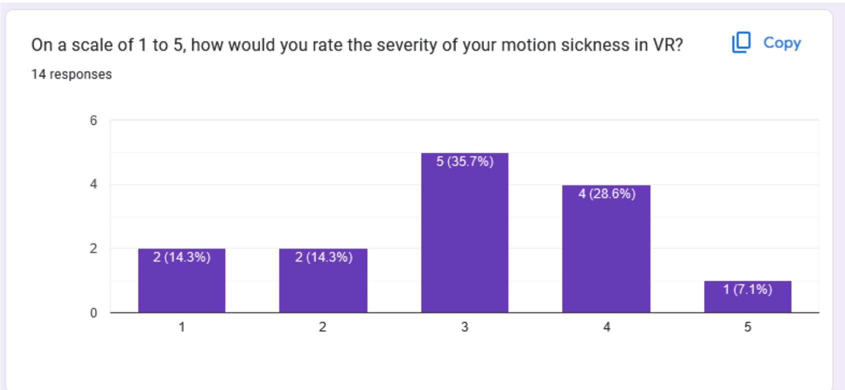
Have you ever experienced motion sickness while using VR technology?

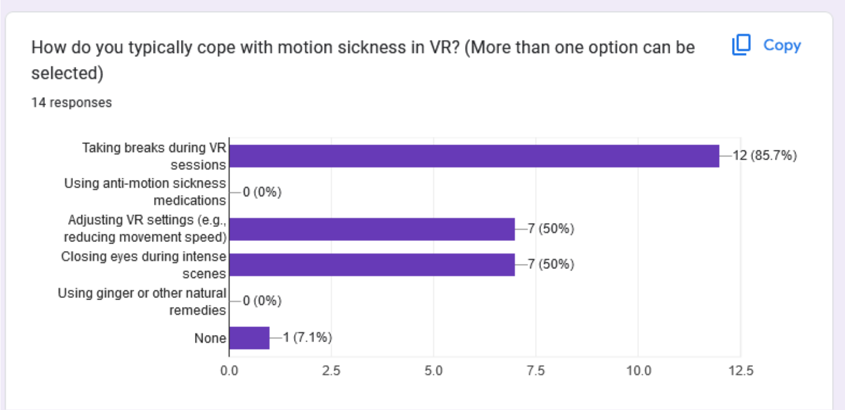
14 responses



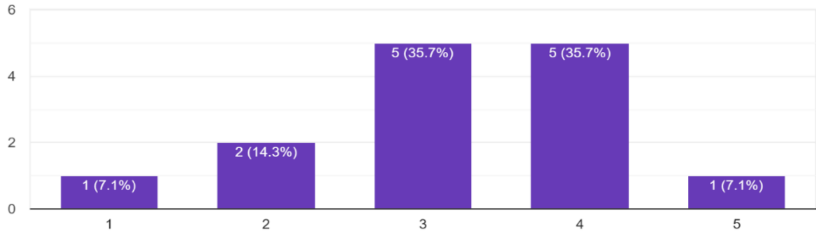

Which of the following physical discomfort do you experience during motion sickness in VR? (More than one option can be selected)
Copy
14 responses
Nausea
4 (28.6%)
Dizziness
11 (78.6%)
Sweating
2 (14.3%)
Headache
9 (64.3%)
Fatigue
5 (35.7%)
None
1 (7.1%)
0.0
2.5
5.0
7.5
10.0
12.5


Which of the following factors trigger motion sickness for you in VR? (More than one option can be selected)
Copy
14 responses
Rapid movement
13 (92.9%)
Virtual Camera Rotation
3 (21.4%)
Virtual Vehicle Travel
4 (28.6%)
Environmental Changes (e.g.,...
8 (57.1%)
Field of View (FOV)
6 (42.9%)
Lack of Control
1 (7.1%)
None
1 (7.1%)
0
5
10
15


On a scale of 1 to 5, how would you rate the severity of your motion sickness in VR?
Copy
14 responses
6
4
2
0
2 (14.3%)
2 (14.3%)
5 (35.7%)
4 (28.6%)
1 (7.1%)
1
2
3
4
5


How do you typically cope with motion sickness in VR? (More than one option can be selected)
Copy
14 responses
Taking breaks during VR sessions
12 (85.7%)
Using anti-motion sickness medications
0 (0%)
Adjusting VR settings (e.g., reducing movement speed)
7 (50%)
Closing eyes during intense scenes
7 (50%)
Using ginger or other natural remedies
0 (0%)
None
1 (7.1%)
0.0
2.5
5.0
7.5
10.0
12.5

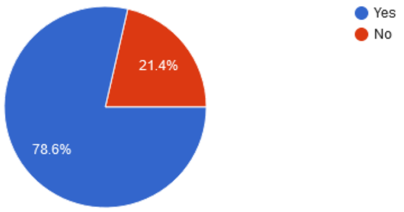
On a scale of 1 to 5, how much does motion sickness affect your enjoyment of VR experiences?
14 responses



Was there options to optimize your comfort settings?

Copy

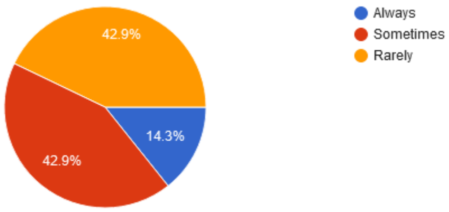
14 responses



Do you typically utilize VR comfort settings (e.g., comfort mode, vignette, teleportation) when available?

Copy

14 responses



Is there anything else you would like to share about your experience with motion sickness in VR or any suggestions to improve VR experiences?
4 responses

Sometimes I just stop using it once I not feeling well although I would really like to continue. Hopefully there are some new technologies / ways to enhance user experience in VR.

I do experienced motion sickness, but I started to get used to it. However, it would be great if there are new ways to help user to cope with it to have a better user experience

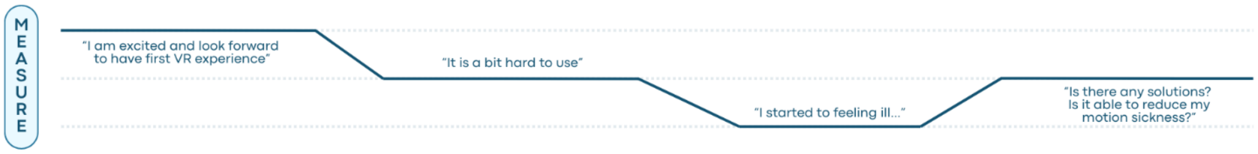
I dont like to change the comfort settings in order to reduce my motion sickness because I look for immersive experience. Therefore I hope that VR technology could be improved day by day so that we can use VR to its fullest

Im not sure if all VR technology are the same or not but I had really bad experiences using VR for the first time...

Appendix 2: User Journey Map

User Journey Map: Experiencing Virtual Reality (VR)

First Phase	Second Phase	Third Phase	Fourth Phase
• Obtaining a VR device or an opportunity to try VR technology • Setting up VR device following tutorials	• Starting to experience VR • Engaging with VR content	• Experiencing different state of motion sickness	• Trying out solutions to reduce motion sickness • Activating and adjusting available comfort settings • Taking breaks or quit



Touchpoints: User manuals, tutorials	**Touchpoints:** VR applications, VR headset, user interface **Painpoints:** Initial learning curve, may start experiencing early motion sickness symptoms	**Touchpoints:** VR applications, VR headset, user interface **Painpoints:** Possibility in ending VR sessions, feeling that VR is not suitable for them to use	**Touchpoints:** VR settings, customer support **Painpoints:** VR experience interruption to find solutions, possible continued motion sickness

Appendix 3: Personas

Persona

Name: John Carson

Age: 30

Marital Status/Family: Divorced ; Live alone

Background

John, a cashier with a high school diploma, lives alone after his marriage ended. After his marriage ended three years ago, he found solace in virtual reality (VR) gaming, which quickly became his main source of joy. Living alone in a modest apartment, Jon spends hours everyday immersed in VR worlds after work, escaping the loneliness and stress of his daily life.

Emotion and Attitude

Jon is passionate about gaming, immersing himself in VR worlds to escape the sadness and loneliness of his daily life. He values the freedom and excitement that VR gaming provides, finding solace in its immersive experiences. In gaming, particularly as he unlocks achievements, Jon finds a sense of personal worth and accomplishment that he struggles to find elsewhere.

Personal Trait

Persistent and dedicated gamer; Introvert

Situation

Jon, already proficient in VR gaming, has been given the opportunity to participate in a highly competitive VR gaming tournament. However, he faces a challenge as he typically reduces his motion sickness by taking frequent breaks during gameplay.

Scenario

Determined to maximize his training efforts, Jon decides to invest his savings in the Adaptive Comfort System for Virtual Reality (ACSVR), despite initial hesitation. As he sets up the ACSVR system and begins playing his favorite VR games, he notices a remarkable difference in his comfort level. The ACSVR's real-time adjustments provide Jon with a seamless gaming experience, allowing him to play for extended periods with minimal motion sickness. With this newfound ability to immerse himself fully in VR without interruption, his performance improves significantly.

Persona

Name: David Kim

Age: 37

Marital Status/Family: Married ; Dink

Background

David is a 37-year-old teacher working in a secondary school. He has been married for five years to his colleague, Maria. They enjoy a comfortable lifestyle as DINKs (Dual Income, No Kids), allowing them the freedom to pursue their interests and hobbies together. Therefore, Alex is always eager to explore new entertainments to spend quality time with Maria.

Emotion and Attitude

David approaches life with optimism and a spirit of "work hard, play hard," balancing his dedication to his career with a commitment to enjoying life to the fullest.

Personal Trait

Adaptable; Values relationships

Situation

David and his wife have always been committed to exploring new things. However, recently, his wife was dissatisfied with the lack of "us time" due to his busy work schedule. Therefore, David decided not to deal with work matters after work and focus on spending quality time with Maria. Therefore, he began to explore new entertainments that he can experience with Maria, which is playing VR together.

Scenario

David decided to try out virtual reality (VR) gaming with his wife to spend more quality time together. However, their excitement turned into discomfort as they both experiencec motion sickness during their first session. Determined to overcome this problem, David found Adaptive Comfort System for Virtual Reality (ACSVR), which successfully reduced their discomfort with the real-time suggestions and adjustment. Despite they still need time to get used to the immersive VR world, David feels relieved that they overcame this relationship crisis.

Persona

Name: Sarah Lopez

Age: 22

Marital Status/Family: Single ; Live alone

Background

Sarah Lopez is a diligent student pursuing her undergraduate degree in Computer Science. Her main responsibilities include attending lectures, completing assignments, and conducting research for projects. She is tech-savvy, proficient in using various software tools for coding and design tasks. Apart from her studies, she is also a part-time tutor, helping high school students with their math and science subjects. She actively participates in community service initiatives, volunteering at local shelters during weekends.

Emotion and Attitude

Sarah Lopez is enthusiastic about technology, using various software tools effectively in her studies as a diligent undergraduate student in Computer Science. She actively engages in lectures, assignments, and research projects, demonstrating a positive attitude towards her academic pursuits.

Personal Trait

Enthusiastic ; Diligent ; Compassionate

Situation

Sarah is passionate about gaming and VR technology. She is participating in a semester-long VR development course where she and her classmates are tasked with creating an immersive VR game. The project requires long hours of VR testing and coding.

Scenario

She recently purchased a VR headset to both play immersive games and learn VR development. However, she often feels motion sick after short VR sessions, which limits her ability to enjoy and work with VR. After hearing about the Adaptive Comfort System for Virtual Reality (ACSVR) from a friend, Sarah decides to try it out. She installs the system, noticing a significant reduction in motion sickness. With the ACSVF system adjusting the VR environment in real-time, Sarah can enjoy longer gaming sessions and focus on her VR development projects without discomfort. Excited about the improvement, she shares her positive experience with her classmates and provides feedback to the developers to help refine the system.

Appendix 4: Heuristic Evaluation (Scorecards)

UX-2-1:

Audrey Labrie and Jinghui Cheng adapted the original heuristics guidelines—created by Jakob Nielsen and Rolf Molich—for a mobile AR context. These guidelines are more than just suggestions; they can be used as a scorecard to evaluate how an AR app performs on each criterion and where to improve the UX.

You can find the expanded versions of each heuristic below the tables for reference.
Source: **https://arxiv.org/pdf/2008.03174.pdf**, Labrie & Cheng 2020

Rating	**0**	**1**	**2**	**3**	**4**
Visibility of system status.	✓				
Match between the system and the real world.	✓				
User control and freedom.		✓			
Consistency and standards.		✓			
Error prevention.		✓			
Recognition rather than recall.	✓				
Aesthetic and minimalist design.	✓				
Help users recognize, diagnose, and recover from errors.		✓			
Help and documentation.	✓				

Notes:
Add back button, symbols need to align up, let user customise boundary (or default). add informative description, add settings - display bpm or not/transparency/colout/stability, add a setting to adjust the level of how the acsvr affects/ adjusts the environment

UX-4-2:

Audrey Labrie and Jinghui Cheng adapted the original heuristics guidelines—created by Jakob Nielsen and Rolf Molich—for a mobile AR context. These guidelines are more than just suggestions; they can be used as a scorecard to evaluate how an AR app performs on each criterion and where to improve the UX.

You can find the expanded versions of each heuristic below the tables for reference.
Source: **https://arxiv.org/pdf/2008.03174.pdf**, Labrie & Cheng 2020

Rating	**0**	**1**	**2**	**3**	**4**
Visibility of system status.	✓				
Match between the system and the real world.	✓				
User control and freedom.				✓	
Consistency and standards.	✓				
Error prevention.			✓		
Recognition rather than recall.	✓				
Aesthetic and minimalist design.		✓			
Help users recognize, diagnose, and recover from errors.		✓			
Help and documentation.		✓			

Notes:
Provide error prevention, the design can be better by utilizing space and paddings. There is also no confirmation message after modification is done
on the personalized system. Lastly, there are no descriptions provided for the features.

Appendix 5: Quantitative Usability Testing (USE Scorecards)

User 1: Shahryar

Rating your feature

Determine how much you agree with each statement:

-2	-1	0	+1	+2
Completely disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Completely agree

Context: Harmonize with user's contexts of use

The feature adapts to user goals in the intended contexts of use.	+2
The feature sustains the stress of the setting.	+2
The feature syncs with the user's VAK limitations (visual, auditory, kinesthetic).	0
The user will be able to operate the feature in varying attention deficit or altered states.	+1
Total	5

Error: Prevent, cushion and reverse user errors

The feature prevents users from making errors whenever possible.	+2
The feature provides a cushion when a potentially serious error is about to be made.	+2
Icons and isual elements (hard/soft key) require no interpretation past a few seconds.	+2
The user is able to easily reverse or continue their task without any problem-solving.	+2
Total	8

[Continued from previous page]

Interaction: Build intuitiveness in by removing understanding

The feature rquires no interpretation — it will offer an affordance for use.	+2
The user can easily find what to do next.	+2
The feature requires no understanding, knowledge, or any prior background or information.	+1
The user can perform tasks successfully without help, training, or discovery time.	+2
Total	7

Scoring your feature

Interpret the total score for each section as follows:

<0	0–2	3–5	6–8
Major flaw	Problem	Good	Excellent

User 2: Lee Lee Choo

Rating your feature

Determine how much you agree with each statement:

-2	-1	0	+1	+2
Completely disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Completely agree

Context: Harmonize with user's contexts of use

The feature adapts to user goals in the intended contexts of use.	+1
The feature sustains the stress of the setting.	+2
The feature syncs with the user's VAK limitations (visual, auditory, kinesthetic).	+1
The user will be able to operate the feature in varying attention deficit or altered states.	+1
Total	+5

Error: Prevent, cushion and reverse user errors

The feature prevents users from making errors whenever possible.	+1
The feature provides a cushion when a potentially serious error is about to be made.	+1
Icons and isual elements (hard/soft key) require no interpretation past a few seconds.	+2
The user is able to easily reverse or continue their task without any problem-solving.	+1
Total	+5

[Continued from previous page]

Interaction: Build intuitiveness in by removing understanding

The feature rquires no interpretation — it will offer an affordance for use.	+1
The user can easily find what to do next.	+2
The feature requires no understanding, knowledge, or any prior background or information.	+2
The user can perform tasks successfully without help, training, or discovery time.	+1
Total	+6

Scoring your feature

Interpret the total score for each section as follows:

<0	0–2	3–5	6–8
Major flaw	Problem	Good	Excellent

User 3: Choong Zhi Hang

Rating your feature

Determine how much you agree with each statement:

-2	-1	0	+1	+2
Completely disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Completely agree

Context: Harmonize with user's contexts of use

The feature adapts to user goals in the intended contexts of use.	+2
The feature sustains the stress of the setting.	+1
The feature syncs with the user's VAK limitations (visual, auditory, kinesthetic).	+1
The user will be able to operate the feature in varying attention deficit or altered states.	+2
Total	+6

Error: Prevent, cushion and reverse user errors

The feature prevents users from making errors whenever possible.	+1
The feature provides a cushion when a potentially serious error is about to be made.	+2
Icons and isual elements (hard/soft key) require no interpretation past a few seconds.	+2
The user is able to easily reverse or continue their task without any problem-solving.	+2
Total	+7

[Continued from previous page]

Interaction: Build intuitiveness in by removing understanding

The feature rquires no interpretation — it will offer an affordance for use.	+1
The user can easily find what to do next.	+2
The feature requires no understanding, knowledge, or any prior background or information.	+1
The user can perform tasks successfully without help, training, or discovery time.	+2
Total	+6

Scoring your feature

Interpret the total score for each section as follows:

<0	0–2	3–5	6–8
Major flaw	Problem	Good	Excellent

User 4: Choong Chin Siang

Rating your feature

Determine how much you agree with each statement:

-2	-1	0	+1	+2
Completely disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Completely agree

Context: Harmonize with user's contexts of use

The feature adapts to user goals in the intended contexts of use.	+2
The feature sustains the stress of the setting.	+2
The feature syncs with the user's VAK limitations (visual, auditory, kinesthetic).	+0
The user will be able to operate the feature in varying attention deficit or altered states.	+1
Total	+5

Error: Prevent, cushion and reverse user errors

The feature prevents users from making errors whenever possible.	+1
The feature provides a cushion when a potentially serious error is about to be made.	0
Icons and isual elements (hard/soft key) require no interpretation past a few seconds.	+2
The user is able to easily reverse or continue their task without any problem-solving.	+2
Total	+5

[Continued from previous page]

Interaction: Build intuitiveness in by removing understanding

The feature rquires no interpretation — it will offer an affordance for use.	+2
The user can easily find what to do next.	+2
The feature requires no understanding, knowledge, or any prior background or information.	+2
The user can perform tasks successfully without help, training, or discovery time.	+2
Total	+8

Scoring your feature

Interpret the total score for each section as follows:

<0	0–2	3–5	6–8
Major flaw	Problem	Good	Excellent

Appendix 6: Qualitative Usability Testing (USE Scorecards)

User 1: Liau Yi Huan

Rating your feature

Determine how much you agree with each statement:

-2	-1	0	+1	+2
Completely disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Completely agree

Context: Harmonize with user's contexts of use

The feature adapts to user goals in the intended contexts of use.	+1
The feature sustains the stress of the setting.	+1
The feature syncs with the user's VAK limitations (visual, auditory, kinesthetic).	+1
The user will be able to operate the feature in varying attention deficit or altered states.	+2
Total	+5

Error: Prevent, cushion and reverse user errors

The feature prevents users from making errors whenever possible.	+2
The feature provides a cushion when a potentially serious error is about to be made.	+2
Icons and isual elements (hard/soft key) require no interpretation past a few seconds.	0
The user is able to easily reverse or continue their task without any problem-solving.	+2
Total	+6

[Continued on next page]

Interaction: Build intuitiveness in by removing understanding

The feature rquires no interpretation — it will offer an affordance for use.	+2
The user can easily find what to do next.	+1
The feature requires no understanding, knowledge, or any prior background or information.	+1
The user can perform tasks successfully without help, training, or discovery time.	+1
Total	+5

Scoring your feature

Interpret the total score for each section as follows:

<0	0–2	3–5	6–8
Major flaw	Problem	Good	Excellent

User 2: Yanny Liam Yuan

Rating your feature

Determine how much you agree with each statement:

-2	-1	0	+1	+2
Completely disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Completely agree

Context: Harmonize with user's contexts of use

The feature adapts to user goals in the intended contexts of use.	+1
The feature sustains the stress of the setting.	+1
The feature syncs with the user's VAK limitations (visual, auditory, kinesthetic).	+2
The user will be able to operate the feature in varying attention deficit or altered states.	+1
Total	+5

Error: Prevent, cushion and reverse user errors

The feature prevents users from making errors whenever possible.	+2
The feature provides a cushion when a potentially serious error is about to be made.	0
Icons and isual elements (hard/soft key) require no interpretation past a few seconds.	+1
The user is able to easily reverse or continue their task without any problem-solving.	+2
Total	+5

[Continued on next page]

Interaction: Build intuitiveness in by removing understanding

The feature rquires no interpretation — it will offer an affordance for use.	+2
The user can easily find what to do next.	+2
The feature requires no understanding, knowledge, or any prior background or information.	+1
The user can perform tasks successfully without help, training, or discovery time.	+2
Total	+7

Scoring your feature

Interpret the total score for each section as follows:

<0	0–2	3–5	6–8
Major flaw	Problem	Good	Excellent

User 3: Tee Jin Sheng

Rating your feature

Determine how much you agree with each statement:

-2	-1	0	+1	+2
Completely disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Completely agree

Context: Harmonize with user's contexts of use

The feature adapts to user goals in the intended contexts of use.	+1
The feature sustains the stress of the setting.	+1
The feature syncs with the user's VAK limitations (visual, auditory, kinesthetic).	+2
The user will be able to operate the feature in varying attention deficit or altered states.	+2
Total	+6

Error: Prevent, cushion and reverse user errors

The feature prevents users from making errors whenever possible.	+1
The feature provides a cushion when a potentially serious error is about to be made.	+2
Icons and isual elements (hard/soft key) require no interpretation past a few seconds.	+1
The user is able to easily reverse or continue their task without any problem-solving.	+1
Total	+5

[Continued on next page]

Interaction: Build intuitiveness in by removing understanding

The feature rquires no interpretation — it will offer an affordance for use.	+1
The user can easily find what to do next.	+2
The feature requires no understanding, knowledge, or any prior background or information.	+2
The user can perform tasks successfully without help, training, or discovery time.	+2
Total	+7

Scoring your feature

Interpret the total score for each section as follows:

<0	0–2	3–5	6–8
Major flaw	Problem	Good	Excellent

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Contribution Statement

Milestone 1

Name	Contribution
Thien Tze Yea 22022123 (22.5%)	- Contributed on deciding project - Designed user journey map - Helped in creating persona - Created user stories and acceptance criteria - Prepared presentation slides - Modified slides after feedback session - Wrote persona part - Modified user research part - Added appendix - Tidy and finalize final report
Muhammad Aqif Danial 18073551 (22.5%)	- Contributed on deciding project - Designed user journey map - Distributed Google Form survey - Modified slides after feedback session - Created persona - Presentation
Tan Hui Xin 22020895 (22.5%)	- Developed questionnaire questions on motion sickness for user research - Distributed Google Form survey - Created persona - Wrote problem statement - Wrote references part
Chong Jing Ying 21088661 (22.5%)	- Created Google Forms - Distributed Google Form survey - Wrote the solution overview - Modify user research part

	- Created persona - Tidy and finalize final report - Modified slides after feedback session
Choong Zhi Khai 20021135 (10%)	- Created persona - Conducted research on selected project - Suggested one question for Google Form survey - Wrote the user research part - Presentation

Milestone 2

Name	Contribution
Thien Tze Yea 22022123 (21.25%)	- Designed task analysis and user flow - Modified user flow - Drew wireframe - Assisted in preparing presentation slides - Modified wireframe after feedback session - Modified slides after feedback session - Wrote wireframe part in report - Finalized report
Muhammad Aqif Danial 18073551 (21.25%)	- Designed task analysis - Modified user flow - Brainstormed ideas for wireframe - Helped with designing the wireframe - Proofreading the report
Tan Hui Xin 22020895 (21.25%)	- Designed task analysis and user flow - Wrote interaction model part in report - Prepared presentation slides - Presentation
Chong Jing Ying 21088661 (21.25%)	- Designed task analysis and user flow - Drew task analysis - Prepared presentation slides - Wrote user flow part in report - Wrote interaction model part in report - Presentation
Choong Zhi Khai 20021135 (15%)	- Drew task analysis - Designed user flow - Finalized report

Milestone 3

Name	Contribution
Thien Tze Yea 22022123 (21.25%)	- Conducted heuristic evaluation - Created digital mock-up - Conducted pilot test - Film and edit video - Prepare presentation slides - Presentation - Wrote pilot test and digital mock-up part in report - Finalized report
Muhammad Aqif Danial 18073551 (21.25%)	- Conducted heuristic evaluation - Contributed to making the video - Wrote heuristic evaluation part in report - Proofreading the report
Tan Hui Xin 22020895 (21.25%)	- Conducted heuristic evaluation - Participated in pilot test - Created poster - Help finalizing final design - Wrote final design part in report
Chong Jing Ying 21088661 (21.25%)	- Conducted heuristic evaluation - Participated in pilot test - Conducted usability testing (Qualitative) - Help finalizing final design - Wrote usability testing part in report
Choong Zhi Khai 20021135 (15%)	- Conducted heuristic evaluation - Share and conducted usability testing (Quantitative) - Wrote usability testing part in report