**Aims**

The primary aim of this project is to explore the viability of Virtual Reality (VR) to assist people with learning disabilities with independent travelling.

A subsequent aim of this project is to demo a suitable system through a VR1 study and a VR2 trial on appropriate navigation paradigms that enable individuals with learning disabilities to navigate a virtual space with minimal risk of experiencing motion sickness.

**Objectives**

• Examine and analyse the current Independent Travel Training process by reviewing the positive impact it has had and its current limitations.

• Investigate the current effectiveness of VR as a Travel Training tool through comprehensive research into Travel Training studies and the predecessors to this application.

• Learn and gain an in-depth understanding of the experiences of those with learning disabilities, especially regarding independent travel.

• Prototype a VR Travel Training application that aligns with existing research and includes new ideas to create a useful tool that can be used by people with learning disabilities to build up their independent travel confidence.

• Conduct research and testing ethically, legally, and professionally in compliance with the British Computing Society’s (BCS) Code of Conduct.

• Document and report on the findings of this project in a detailed and comprehensive manner so that it may be used to supplement the understanding of interaction paradigms and locomotion in future research.

**Brief Description**

This project aims to build upon existing research into the use of virtual reality for independent travel training. Moreover, the project will focus on a particular question concerning navigation and interaction paradigms in the virtual world and what method might cause the least amount of motion sickness in the application’s users.

To achieve this, the project will trial different methods of locomotion through the application’s content with the inclusion of varying latency rates via VR hardware to determine the most suitable combination of hardware and content for its VR application based on conclusions drawn from the testing results with the participant group.

**Summarise the Background to the Project**

A reoccurring theme can be extracted from a review of the relevant publications within this topic area, and one can conclude that interaction paradigms for individuals with learning disabilities are either under-reported or under-researched. This is especially prominent in the case of full immersion into the virtual environment wherein a keyboard and mouse are no longer feasible options for navigation.

As highlighted in (Brown et al. 2002) most participants struggled to use a keyboard and mouse to navigate the virtual world with one participant finding “keyboard control very difficult”. Similarly, a few other studies (Checa et al. in Lucio Tommaso De Paolis, Patrick Bourdot 2019; Cobbs et al. in Sharkey et al. 1998; Shopland et al. 2004) discuss the difficulties participants had with the interaction paradigms surrounding joystick-based navigation and player point of views (POVs) in the virtual learning environments (VLEs). The remaining studies (Strickland et al. 1996; Simões et al. 2018; Bernardes et al. 2015) do not discuss the user’s experience with navigation and locomotion within the virtual world. Subsequently, of all the studies, none measure the potential occurrence of motion sickness as a result of the chosen navigation method.

Thus, this project aims to build upon existing research into the use of virtual reality for independent travel training. Moreover, the project will focus on a particular question concerning navigation and interaction paradigms in the virtual world and what method might cause the least amount of motion sickness in the application’s users. To achieve this, the project will trial different methods of locomotion through the application’s content with the inclusion of varying latency rates via VR hardware to determine the most suitable combination of hardware and content for its VR application based on conclusions drawn from the testing results with the participant group.

**Outline of Methodology**

This research aims to test the effectiveness of the different implemented locomotion paradigms within the Virtual Reality Travel Training simulator context. The application will involve the user progressing through a series of different levels designed to look like typical UK streets wherein they’ll be challenged to cross a road using different crossing types. The users will need to navigate through to complete the level. Level types will include zebra crossing, pelican crossings, crossroad crossing and plain road crossing. Concerning locomotion paradigms, users will have the option to select their preferred method of locomotion at the start of the level. The locomotion paradigm options will include joystick movement and ‘arm-swinging’ walking. The latency rates will be compared through the use of different headsets (PICO 3 or the Oculus Quest 2).

“NICER” are a group of adults with learning difficulties who have prior experience participating in academic research. Users from the “NICER” group will be invited onto campus to participate in the testing of the developed virtual reality travel training application to provide valuable feedback on the effectiveness of the application. Attending teachers/supervisors from Oakfield School will also be present to take part and to help the students, but also to get their views on what the project should focus on going forward.

Each participant will attend a single session guided by the student and supervisor. Each session will be attended by 5 participants. While one participant uses the headset the others will have the opportunity to watch. The HMD perspective of the participant within the VR world will be displayed through a monitor. Before a participant begins their session in VR, they will be given a VR Sickness Questionnaire (VRSQ) to answer. Upon completion of the VRSQ, participants will have the opportunity to pick their preferred headset.

While immersed in the VR application, participants will not be permitted to spend longer than 10 minutes continuously using the headset to avoid motion sickness being caused because of prolonged exposure. The sessions will be 2 hours long allowing for the participants to attempt the multiple levels and locomotive options of the application. Upon completion of a level, participants will be asked to complete another round of the VRSQ. Participants will be timed on how quickly they complete a level.

After a participant has completed all the activities that they wished to participate in within their allocated 2 hours, they will be asked an additional set of questions regarding what they thought of the application, more specifically if they thought the application would be effective in aiding themselves/others in travelling safely/independently and any improvements they feel would be necessary to achieve this outcome in the future, and their thoughts on whether Virtual Reality is suitable for this kind of training.

These sessions will be audio recorded, then transcribed and anonymised afterwards. Notes will also be taken throughout the sessions. Insights from these sessions on how the participants found each activity/what worked/what didn’t will be written up and analysed.

**Research Methodology**

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| --- | --- | --- | --- |
| Method | Description of Participants | Why method was selected | How data will be analysed |
| Experimental research via a laboratory experiment. The independent variables are HMD latency rates and the chosen navigation paradigm. The dependent variable is the extent of motion sickness experienced by participants as measured by the VR Sickness Questionnaire (VRSQ) and the speed at which they complete a level.  The experiment aims to determine the relationship between the variables to conclude which navigation paradigm and HMD are best suited for the application with its user group, individuals with learning disabilities. | “NICER” are a group of adults with learning difficulties who have prior experience participating in academic research.  Users from the “NICER” group will be invited onto campus to participate in the testing of the developed virtual reality travel training application to provide valuable feedback on the effectiveness of the application. Attending teachers/supervisors from Oakfield School will also be present to take part and to help the students, but also to get their views on what the project should focus on going forward. | The method was chosen as it allows the project to determine the cause-and-effect relationship between the outlined variables.  Moreover, it gives the project control over the variables so that they can be manipulated when needed. Subsequently, the method allows for easy replication in future iterations of the project. | Participants’ VRSQ scores from before and after each level will be calculated and compared against each other to determine whether the chosen HMD and navigation paradigm increased their VRSQ score. In addition to this, participants’ speed at which they complete a level will be compared against each other.  The results from each of the chosen combinations will be assessed against each other to determine which pairing of HMD and navigation method results in the quickest level completion time and reduced reporting of motion sickness based on VRSQ scores.  Furthermore, these sessions will be audio recorded, then transcribed and anonymised afterwards. Notes will also be taken throughout the sessions. Insights from these sessions on how the participants found each activity/what worked/what didn’t will be written up and analysed to determine additional changes needed to improve the overall application experience. |

**Describe how the research will be conducted in a way that ensures its quality and integrity.**

The project does not include any conflicts of interest. Moreover, concerning data collection and management, to ensure the project’s testing sessions produce valid results, the project will employ the use of a validated questionnaire (Virtual Reality Sickness Questionnaire) to measure the extent of motion sickness caused by the application. Data will be managed in adherence to the regulations outlined by the Data Protection Act.

Furthermore, the findings of the project will be analysed and discussed in detail with consideration of how it might relate to the existing understanding of the relationship between motion sickness and Virtual Reality navigation paradigms. These conclusions will be documented within the report.

**Please describe what types of data will be collected, and for each type, describe how it will be collected.**

**Quantitative Questionnaire Data:** Each participant will attend a single session guided by the student and supervisor. Each session will be attended by 5 participants. While one participant uses the headset the others will have the opportunity to watch. The HMD perspective of the participant within the VR world will be displayed through a monitor. Before a participant begins their session in VR, they will be given a VR Sickness Questionnaire (VRSQ) to answer. Upon completion of the VRSQ, participants will have the opportunity to pick their preferred headset.

While immersed in the VR application, participants will not be permitted to spend longer than 10 minutes continuously using the headset to avoid motion sickness being caused because of prolonged exposure. The sessions will be 2 hours long allowing for the participants to attempt the multiple levels and locomotive options of the application. Upon completion of a level, participants will be asked to complete another round of the VRSQ.

**Quantitative Level Completion Speed Data:** Participants will also be timed on how quickly they complete a level. The timer will begin once they’ve entered the level and stopped once they reach the designated endpoint.

**Qualitative Interview Data:** After a participant has completed all the activities that they wished to participate in within their allocated 2 hours, they will be asked an additional set of questions outlined in the attached ‘Discussion Questions’ document.

These sessions will be audio recorded, then transcribed and anonymised afterwards. Notes will also be taken throughout the sessions. Insights from these sessions on how the participants found each activity/what worked/what didn’t will be written up and analysed.

**Please describe arrangements for physical and technical security measures. This may include (but is not limited to) access controls in work spaces, use of encrypted devices, password-protected documents or controlling editing rights on shared documents.**

The ISTEC 004 (Virtual Reality) Lab that’ll be used for the testing sessions requires a valid ID card to access the space. In addition to this, all documentation involved in the project will be securely kept within a password-protected OneDrive folder. Edit access to the documents will be limited to the student and supervisor only.

Group discussions will be recorded and transcribed. In the transcription, the participants’ names will be replaced with an anonymised ID, and then the original audio file will be destroyed. Any other information that could also be used to directly identify any individual from this transcription will also be removed. A table linking each participant's ID number to their name will be stored in a password-protected folder on OneDrive. After 4 weeks this table will also be destroyed, and the participants will be unable to withdraw.

**Please describe what data will be collected and processed during the project. This includes but is not limited to:**

* *secondary data, including data curated for public access and display or re-use by researchers, material held in archives or private collections*
* *personal data including audio recordings, interviews, survey data*
* *physiological data*
* *financial or organisational data.*

*You can also refer to any existing Data Management Plans uploaded to this application or the underlying project.*

Virtual Reality Sickness Questionnaire data will be collected from participants before and after each level that they complete. This will be processed using the formula outlined in the VRSQ research paper. In addition to the above, participants’ speed of level completion data will also be collected to be used as another factor in determining the extent of motion sickness.

The project will also collect interview data from the participants after the entire testing session is complete. This will include questions outlined in the attached ‘Discussion Questions’ document, for example, questions regarding what they thought of the application, more specifically if they thought the application would be effective in aiding themselves/others in travelling safely/independently and any improvements they feel would be necessary to achieve this outcome in the future, and their thoughts on whether Virtual Reality is suitable for this kind of training

Audio recordings of the testing sessions will also be obtained. These will be transcribed and anonymised afterwards. Furthermore, notes will also be taken throughout these sessions. Insights from these sessions on how the participants found each activity/what worked/what didn’t will be written up and analysed.

**Please give details of the data storage arrangements that will be in place during your project or refer to the Data Management Plan. This may include both digital and hard copy storage.**

All project data will be stored in a password-protected One Drive folder. This will also be backed up to an encrypted USB. Only the student and supervisor will have access to the folder and USB. Data will be organised via folders based on where it’s derived from (i.e., VRSQ Results or recordings). The anonymised data will be stored securely on OneDrive for 5 years in line with the data protection act.

If a participant wishes to withdraw after data collection, they will be able to let a member of the NTU research team, or Oak Field staff, know. Any reference to them, or their ID, will be removed from the transcript, and their entry will be removed from the table linking the ID number to the name. This will only be possible up to 4 weeks after the VR session.