An investigation into how virtual reality can influence sensory perceptions of reality.

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1 Introduction

Virtual reality provides visual experiences via optical immersion. A key feature of VR is its capability to induce complete visual immersion. If a user is completely immersed within their virtual domain, the domain itself could be altered to enhance their experience. Redirected walking is an example, where subtle rotation of a virtual plane subconsciously prompts a user to change direction (Razzaque, 2001) emulating a larger domain for walking.

The aim of this project is to understand ways virtual reality can influence sensory perceptions of reality. A key part of the project experiment will use VR to make small nuanced changes to a users sensory perceptions without their knowledge. Such an influence should make a participant believe theyre operating in one way, when in a real world domain they are subtly acting in another.

This dissertation will comprise two separate experiments. Both experiments will exhibit a scenario in both a real and virtual environment. The virtual domain however, will dynamically alter in order to divide real and virtual world perception. From this, differences in participant actions between the two domains will be exhibited. Therefore VRs influence on a users reality can be evaluated and discussed.

Initially experimental scenarios have to be defined, this will require research into how perception can influence a humans decisions. Next, the Unity 5 game engine will be utilised in order to create and animate a virtual environment. A HTC Vive headset will place a user in the virtual environment. Its software plugins will be added to Unity 5 in order to create an intractable domain. Depending on scenario choices, real world apparatus will likely need to be sourced for interaction in real and virtual planes.

For the future, VR has applicability in social media. Since VR creates a sense of presence, it may provide a more personal way to communicate over long distances instead of web-cam chats. It is therefore understandable why Facebook acquired Oculus in 2014.

VR has also potential applicability within the gaming industry. However, its emancipatory confounds restrict exploration and varied motion, which in turn breaks the illusion of walking around a real domain. This problem has been addressed with add-on hardware such as the Virtuix Omni. However two key

obstacles face a 3rd party hardware solution (such as the Omni). Metaphorically its integration with developed software and literally its potential size. This indicates the need for a different solution. One way investigating VRs influence on real perception could form a solution, is by examining how virtual motion could simulate real motion. Therefore giving a player the sensation of traveling a long distance virtually than that in reality, and thus increasing the perceptive size of the virtual domain.

1.1 Aim

- An investigation into how virtual reality can influence sensory perceptions of reality.

1.2 Objectives

1. Research at least 5 pieces of literature which have a concurrent theme involving human sensory perception, before designing an experimental scenario.
    - This research will be a crucial asset when constructing a system and scenario that targets the primary aim. Information will be discovered through research of academic journals and books relating to VR and cognitive science.
2. Design 2 experimental scenarios, which force a participant to rely on a sensory system to achieve a given goal.
    - A scenario presents a task and prompts the user's to achieve a goal. A given task will to be very simple, i.e. walking in a straight line towards a point. Simple tasks will enable a clear and concise way to gather evaluative data. The scenario will be displayed within a virtual environment; therefore technological possibilities and limitations have to be considered.
    - Scenario designs will be in the form of storyboards.
3. Design 2 VR systems which appropriately meet the needs of each scenario design, before any software implementation.
    - The system design will incorporate all requirements from the scenario.
    - Hardware and software requirements will be considered in order to outline realistic capabilities of the system.
    - Designs will be in the form of UML diagrams.
4. Develop 2 VR systems which accurately follow their design schematics and appropriately presents the scenarios.

- The system will adhere to the design schematic using the Unity 5 Game engine to create the virtual environment. A HTC Vive will be utilised to display the scenario and track the user within a virtual plane.

5. At the end of the project, evaluate future applications of the developed technology.

2 Literature Review

The key goal of this project is to measure the influence VR has on the perceptions of reality. Emulating motion within a virtual domain is one way of doing this. Visually induced motion is suggested to significantly enhance self-motion perception within VR (Riecke, 2015). However, Brendan Walkers creation Oscillate suggests otherwise.

Essentially, oscillate is a real swing with simulated visuals (Vans, 2015). In adopting the swing idea and using real world motion within a virtual environment, a comparison can be made between swinging in a real and virtual domain. By altering factors within the virtual domain, for example environmental height, it can be seen whether the virtual environment can influence perceptions of increased motion. In contrast, the antithesis of visually induced motion of where the user swings but has a still visual field could produce results, which indicate perceptions of decreased, or no motion. For example, the user sensing stationary motion; whilst slowly swinging in real space.

In order to enhance real locomotion within virtual environment, research suggests an intense sense of presence may be required via body affordances (Tuchet, 2015). Therefore, the integration of hand tracking may aid in to influencing a users perception when altering of the virtual world. In conjunction with this, auditory input of a participant's anthropomorphic appearance could also play a key part in simulating presence and influencing a users sensory perception of an environment.

Creating a sensation of direction is another way of influencing the perception of reality. Grechkin suggests a rotate and walk technique. In his study, if a user is attempting to reach an out of bounds target t the user is then prompted to go to a sub target I. As they walk to I the world rotates to encompass the t again (Grechkin, 2015). The study deceives a users visual sensory information to create a feeling of increased virtual space. By incorporating this technique of world rotation, one could evaluate the extent to which a user goes off track in a real domain when following a track in virtual space. Inaccurate trailing of the real world track would suggest VRs high influence on a users perception of reality. Use of this technique could also be used to address the navigational limitations within VR.

Research indicates little change in the performance of simple activities in real and virtual environments (Heydariana, 2015). Activities include reading speed and object identification. In terms of the project, it would be interesting

to measure how a slight alteration of a user perception in a virtual domain would impact performance in the virtual domain.

3 Gantt Chart

The milestones table displays expected output at the end of each task. As a result, actual output can be compared against this table in order to keep check of project progression.

3.1 Milestones

Task Name	Milestone Output
Research	- List of appropriate literature.
Scenario Design	- 2 scenarios clearly defined. - 2 Storyboards. - Relevant support equipment acquired.
System Design	- UML Class Diagrams
System Setup	- An environment with Vive and Leap motion functionality.
System Development 1	- A scene which displays scenario and has the relevant mechanics required.
System Development 2	- A scene which displays scenario and has the relevant mechanics required.
Testing	- List of system revisions (if any).
System Revisions	- A system which incorporates the required revisions.
Experiment	- Complete user data from questionnaires.
Data Analysis	- Brief written evaluation of results.
Evaluate Dissertation Draft	- Revised dissertation ready for submission.

The list schedule below contains each parent (task) and child (stage) required to complete the project. Rows highlighted in red points where project engagement is halted for other prioritised work.

The Gantt chart itself only features parent tasks due the high number of nested child tasks.

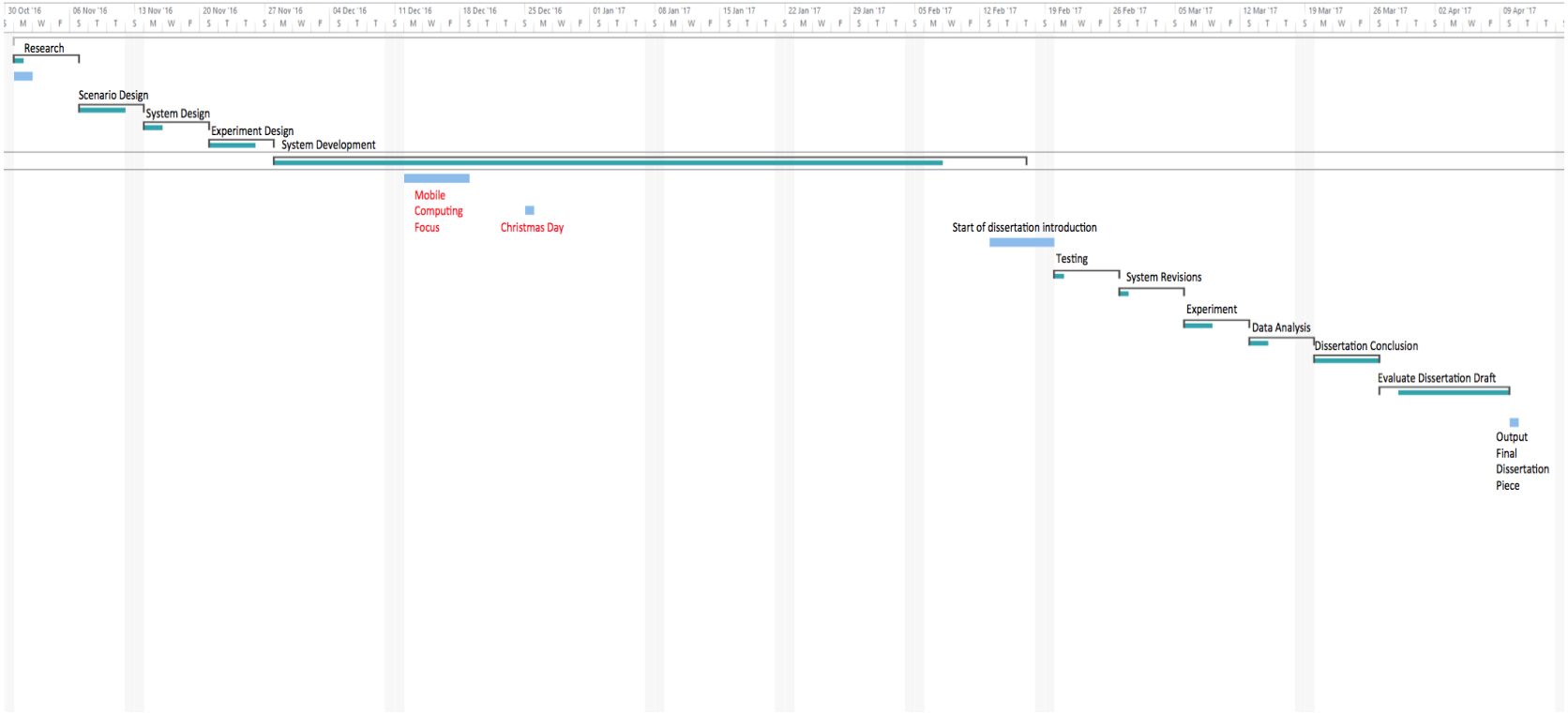
3.2 Schedule

Task Name	Start	Finish
Gant Chart	**Mon 31/10/16**	**Sun 30/04/17**
Research	**Mon 31/10/16**	**Sun 06/11/16**
Find Appropirate Literature Relating To Human Perception	Mon 31/10/16	Mon 31/10/16
Identify and Note Sections Which Aid the Project Aim	Mon 31/10/16	Mon 31/10/16
Research Complete	Mon 31/10/16	Mon 31/10/16
Start Dissertaion Literary Review	Mon 31/10/16	Tue 01/11/16
Scenario Design	**Mon 07/11/16**	**Sun 13/11/16**
Analyse Research to Determine Viable Scenarios For Experiment	Mon 07/11/16	Fri 11/11/16
Determine 2 Scenarios To present for the Experiment	Mon 07/11/16	Wed 09/11/16
Design Storyboards For Both Scenarios	Mon 07/11/16	Mon 07/11/16
Gather Resources/Appertus Required To Implement Scenarios.	Mon 07/11/16	Tue 08/11/16
Scenario Design Complete	Mon 07/11/16	Mon 07/11/16
System Design	**Mon 14/11/16**	**Sun 20/11/16**
Review The Two Scenario Specifications	Tue 15/11/16	Tue 15/11/16
Outline Functional Requirements for both VR Systems	Mon 14/11/16	Mon 14/11/16
Develop a high level component design for each program	Mon 14/11/16	Mon 14/11/16
Evalute designs against scenario/functional specifications	Mon 14/11/16	Mon 14/11/16
System Design Complete	Mon 14/11/16	Mon 14/11/16
Experiment Design	**Mon 21/11/16**	**Sun 27/11/16**
Develop Storyboard For Data Collection For Scenario 1	Mon 21/11/16	Tue 22/11/16
Develop Storyboard For Data Collection For Scenario 2	Mon 21/11/16	Fri 25/11/16
From Both Storyboards Define Experiment Instructions (In Detal)	Mon 21/11/16	Thu 24/11/16
Design complete	Mon 21/11/16	Mon 21/11/16
System Development	**Mon 28/11/16**	**Thu 16/02/17**
Sysetm Setup	**Mon 28/11/16**	**Fri 02/12/16**
Successfully Implement HTC Camera Rig into Unity	Mon 28/11/16	Tue 29/11/16
Successfully Implement Leap Motion into Unity	Mon 28/11/16	Fri 02/12/16
System Development 1	**Mon 05/12/16**	**Thu 29/12/16**
Load Pre-Made sysetm set-up	Mon 05/12/16	Mon 05/12/16
Create and fill scene accoring to scenario design	Mon 05/12/16	Mon 12/12/16
Implement system design (Evironmental Alteration)	Mon 05/12/16	Mon 05/12/16
System Development 2	**Mon 02/01/17**	**Tue 07/02/17**
Load Pre-Made sysetm set-up	Mon 02/01/17	Mon 02/01/17
Create and fill scene accoring to scenario design	Mon 02/01/17	Fri 13/01/17
Implement system design (Evironmental Alteration)	Mon 02/01/17	Fri 20/01/17
Mobile Computing DeadLine (Off Work)	Mon 12/12/16	Sun 18/12/16
Christmas Day (Off Work)	Sun 25/12/16	Sun 25/12/16
Start Dissertation Introduction	Mon 13/02/17	Sun 19/02/17

3.3 Schedule Cont

Testing	**Mon 20/02/17**	**Sun 26/02/17**
Provide functional testing on system 1	Mon 20/02/17	Mon 20/02/17
Note details of requird revisions	Mon 20/02/17	Mon 20/02/17
Provide functional testing on system 2	Mon 20/02/17	Mon 20/02/17
Note details of requird revisions	Mon 20/02/17	Mon 20/02/17
System Revisions	**Mon 27/02/17**	**Sun 05/03/17**
Implent required revisions on system 1	Mon 27/02/17	Mon 27/02/17
Go back to testing phase for system 1	Mon 27/02/17	Mon 27/02/17
Implent required revisions on system 2	Mon 27/02/17	Mon 27/02/17
Go back to testing phase for system 2	Mon 27/02/17	Mon 27/02/17
Experiment	**Mon 06/03/17**	**Sun 12/03/17**
Gather participants for the experiment	Mon 06/03/17	Mon 06/03/17
Conduct experiment for	Tue 07/03/17	Tue 07/03/17
Conduct experiment for	Wed 08/03/17	Wed 08/03/17
Data Analysis	**Mon 13/03/17**	**Sun 19/03/17**
Evalute Results	Mon 13/03/17	Mon 13/03/17
Conduct Results Dissertaion Chapter	Tue 14/03/17	Tue 14/03/17
Conduct Disseration Conclusions	**Mon 20/03/17**	**Sun 26/03/17**
Conduct Analysis Chapter	Mon 20/03/17	Wed 22/03/17
Conduct Discussion Chapter	Thu 23/03/17	Sun 26/03/17
Conduct Conclusions Chapter	Wed 22/03/17	Fri 24/03/17
Conduct Future Work Chapter	Wed 22/03/17	Fri 24/03/17
Evaluate Dissetation Draft	**Mon 27/03/17**	**Sun 09/04/17**
Format Dissertation Chapters Into LATEx	Wed 29/03/17	Wed 29/03/17
Review Disseration Draft	Fri 31/03/17	Mon 03/04/17
Amend Draft Corrections	Mon 03/04/17	Sun 09/04/17
Output Final Disseration Piece	Mon 10/04/17	Mon 10/04/17
Cross Platorm Module Assesment Focus	Mon 24/04/17	Sun 30/04/17
Project Deadline	Thu 27/04/17	Thu 27/04/17

3.4 Chart


30 Oct '16
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05 Feb '17
12 Feb '17
19 Feb '17
26 Feb '17
05 Mar '17
12 Mar '17
19 Mar '17
26 Mar '17
02 Apr '17
09 Apr '17
Research
Scenario Design
System Design
Experiment Design
System Development
Mobile Computing Focus
Christmas Day
Start of dissertation introduction
Testing
System Revisions
Experiment
Data Analysis
Dissertation Conclusion
Evaluate Dissertation Draft
Output Final Dissertation Piece

4 Risk Matrix

Risk	Likelihood	Impact	Risk Quotient (Likelihood x Impact)	Contingency (Numbered to most manageable mitigation)
Participant may become nauseous within Virtual Environment.	**0.5**	**3**	**1.5**	*1. Stop the current trail; give the participant time to recuperate. Restart if they feel comfortable to continue.* *2. If otherwise end the trail and source a new participant from backlog.*
Majority of participants becoming nauseous.	**0.2**	**8**	**1.6**	*1. Investigate the cause of nausea. Modify the system to eliminate the cause. If nausea is link to a crucial component of the system scenario, the scenario may have to be altered.*
Vive access not available for Development	**0.7**	**2**	**1.4**	*1. Continue to develop and postpone testing until Vive is available.* *2. If code does not require Vive plugins or Z-axis motion (world creation), the Samsung Gear VR can be used in order to test development. (This will require an oculus 'Back up' camera rig within the project).*
Vive access not available for experiment as a result of technical malfunction.	**0.1**	**9**	**0.9**	*1. Attempt to source a new VIVE.* *2. Swap to Oculus Camera Rig and conduct experiment with the Oculus Rift. Note this is a last resort, with the risk of extensive system modification and scenario alteration.*
Apparatus not available for experiment as a result of breakage.	**0.2**	**7**	**1.4**	*1. Attempt to quickly source the new apparatus.* *2. Alter project scenario. (Use only one test instead of two)*

References

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