A Virtual Environment to Simulate the Experience of Psychosis

Jasmine Banks[1], Jennifer Tichon[2], Geoffery Ericksson[1], Sean Ivermee[1],
Kevin Burrage[1], and Peter Yellowlees[2]

[1] Advanced Computational Modelling Centre, University of Queensland,
Brisbane 4072, Australia.
{jbanks, gbe, kb}@acmc.uq.edu.au
http://www.acmc.uq.edu.au/
[2] Centre for Online Health, University of Queensland,
Brisbane 4072, Australia.
jtichon@ccs.uq.edu.au, p.yellowlees@mailbox.uq.edu.au
http://www.coh.uq.edu.au/

Abstract. Psychosis is a mental disorder that affects 1–2% of the population at some point in their lives. One of the main causes of psychosis is the mental illness schizophrenia. Sufferers of this illness often have terrifying symptoms such as hallucinations, delusions, and thought disorder. This project aims to develop a virtual environment to simulate the experience of psychosis, focusing on re-creating auditory and visual hallucinations.

A model of a psychiatric ward was created and the *psychosis simulation software* was written to re-create the auditory and visual hallucinations of one particular patient. The patient was very impressed with the simulation, and commented that it effectively re-created the same emotions that she experienced on a day-to-day basis during her psychotic episodes. It is hoped that this work will result in a useful educational tool about schizophrenia, leading to improved training of clinicians, and fostering improved understanding and empathy toward sufferers of schizophrenia in the community, ultimately improving the quality of life and chances of recovery of patients.

1 Introduction

Psychosis is a mental disorder that affects 1–2% of the population at some point in their lives. One of the main causes of psychosis is the mental illness schizophrenia, a chronic, severe and disabling illness, which usually has its onset in late adolescence or early adulthood. The illness is often stigmatised and poorly understood, and sufferers often feel alienated from the community.

1.1 Types of Hallucinations

People with schizophrenia often suffer terrifying psychotic symptoms such as: hallucinations, which are disturbances of sensory perception; delusions, which

are strongly held yet mistaken beliefs; and thought disorder, including unusual speech, thought processes and behaviour. These symptoms may leave them fearful and withdrawn.

Types of auditory hallucinations associated with schizophrenia include: voices that speak aloud the patient's thoughts; voices giving a running commentary on the patient's activities or surroundings; two or more persons conversing, often about the patient who is referred to in the third person; and commands ordering the patient to do things[3].

Visual hallucinations can include flashes of light, straight lines becoming curved, objects shimmering or appearing emphasised, morphing of objects, and elaborate visions. Examples of morphing objects include: words in a newspaper headline, poster or sign changing to spell different words; and faces in pictures, on TV or in real life changing their facial expression or morphing into other entities. Usually visual hallucinations will be accompanied by audio hallucinations, for example, faces on TV may appear to "speak" to the patient.

1.2 Aims of this Project

Virtual Reality (VR) provides a potentially effective tool for translating a person's psychological experience into a simulated experience others can share. This project aims to develop a virtual environment to simulate the experience of psychosis, focusing on re-creating the auditory and visual hallucinations.

Currently, the predominant teaching tools used to educate psychiatry and psychology students about schizophrenia consist of abnormal psychology texts [6]. The virtual psychosis environment will be able to provide an interactive learning experience for students, so that they will gain first hand knowledge of what it is like to experience psychotic hallucinations. It is hoped this will ultimately result in better empathy of doctors with their patients, leading to reduced stress and alienation of patients and better patient outcomes.

In addition, it is known that an important factor in the recovery of patients is the support that they receive from carers, family and the community. The virtual psychosis environment will allow family members and carers to experience and better understand what their loved-ones are going through. It could also be used as a tool for community education and awareness campaigns about schizophrenia, helping to destigmatise the illness, dispel fallacies about the illness, and increase empathy toward suffers.

Another possible application of this work is to test its clinical potential as a tool be used in cognitive behavioural therapy (CBT) [5]. Further into the future, another goal is to enable patients, in conjunction with their therapist, re-create their experiences, so that therapists can better understand and monitor patients' symptoms.

1.3 Related Work

As far as we can determine, there are no other groups worldwide working in the area of using Virtual Reality to simulate psychosis. Related work has been

done in the area of using VR to treat phobias, such as fear of heights, flying and spiders, and post-traumatic stress disorder[2, 4]. Virtual Reality has also been used to simulate a person's altered perceptual world resulting from a stroke [1].

2   The VISAC Laboratory

This project makes use of the VISAC (Visualisation and Advanced Computing) laboratory at the University of Queensland. This laboratory contains an immersive curved screen environment of 2.5 metre radius, providing 150 degrees field of view. Three projectors separated by 50 degrees are used to project the images onto a cylindrical screen. This environment is suitable for having small groups of people sharing the immersive experience. Figure 1 shows the curved screen of the VISAC laboratory, displaying part of the psychiatric ward model.

The graphical display on the curved screen is driven by an SGI Onyx with four 400MHz MIPS R12000 processors, 2Gb main memory, and one InfiniteReality3 graphics pipeline with 256Mb texture memory.

Fig. 1. The curved screen of the VISAC laboratory.

3   Prototype Development – The Living Room Model

A prototype model of an everyday environment, in this case a living room, was built using the commercial 3D modelling package Realax. As well as a modelling tool, this package provides a simplistic run-time environment for the display and interaction with the created models.

The hallucinations modelled include: a face in a portrait morphing from one person into another and also changing its facial expression; a painting on the wall undergoing distortion; the walls of the room contracting, expanding, and distorting so that the straight edges of the room appear curved; the blades of a ceiling fan dipping down; and the TV switching on and off of its own accord. In addition, a soundtrack of auditory hallucinations, provided by the pharmaceutical company Janssen-Cilag, was played as a background to the visual hallucinations. This was in order to approximate the cacophony of voices that
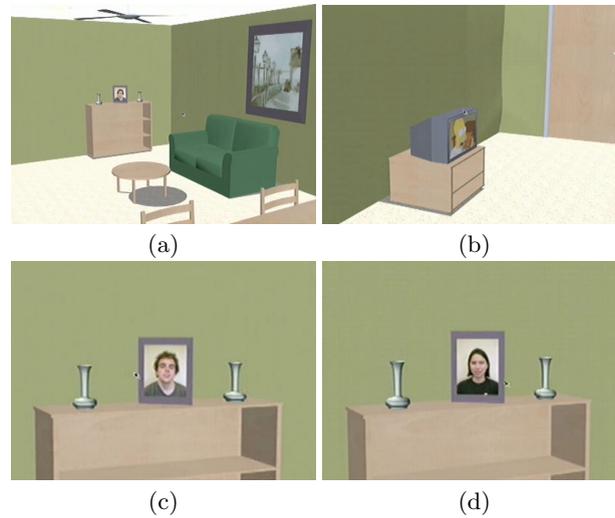
Fig. 2. Snapshots of the living room model: (a) living room scene; (b) TV; (c) portrait; (d) portrait morphed.

would be "speaking" whilst the patient is trying to concentrate on everyday tasks. Some snapshots from the living room model are shown in Figure 2.

Feedback from patients and mental health care organisations was generally positive. However, due to the generic nature of the auditory and visual hallucinations portrayed, it was not possible to confirm how realistic the model was. A number of patients commented that they supported the concept of a virtual psychosis environment, however, that the hallucinations modelled did not actually relate to them.

4 Psychosis Simulation Environment – Version 1.0

Given the positive response to the Prototype Living Room Model, the next stage of the project involved modelling the hallucinations of one particular patient who agreed to be involved in the project. This patient is in the stable phase of her illness, and works as an advocate for patients with schizophrenia and for education of the general public about the illness.

The patient was extensively interviewed by a psychiatrist and the interview recorded. A number of hallucinations were selected to be implemented, with the aim of re-creating the experience of psychosis from the patient's perspective. The hallucinations implemented were as follows:

1. Auditory hallucinations, usually in the form of a running commentary or multiple voices talking about the patient, often telling the patient that she is "evil" or talking in a derogatory manner about the patient's appearance.

2. Religious "hallelujah" music.
3. A political speech on the radio which changes to refer to the patient and ends by commanding the patient to kill themselves.
4. The word "death" standing prominently out of newspaper headlines.
5. Random flashes of light.
6. A vision of the Virgin Mary, which usually would beckon and gesture in a comforting manner, but occasionally would become abusive and swear at the patient.

A virtual psychiatric ward environment was created as a basis for implementing the hallucinations. A psychiatric ward was chosen as it is an environment where many patients would have experienced hallucinations, and could therefore be used as a basis for re-creating the hallucinations of subsequent patients who become involved in the project. It also contains a variety of different rooms such as offices, bedrooms, bathrooms, a common room, hallways and a garden where different types of hallucinations may occur.

Development of the virtual environment and hallucinations comprised two main steps: creating the models of static elements; and development of the *psychosis simulation software.*

4.1   Models of Static Elements

This involved creating the model of the psychiatric ward, and models of the static elements of the scene (eg. furniture) using the 3D modelling package Realax. In order to build a realistic model of a psychiatric ward and the objects within it, a visit was made to the psychiatric ward at the Royal Brisbane Hospital, and photographs taken of various textures and room layouts. The static models of the psychiatric ward and objects were saved as separate VRML files for inclusion into the main program. Figure 3 shows some comparisons between photographs of the actual psychiatric ward and the created model.

4.2   Psychosis Simulation Software

This involved writing the main program which loads, positions and displays the static elements, and also which co-ordinates the dynamic parts of the scene, such as sounds and movements of objects.

The software is designed so that the user is able to navigate around the scene using the mouse and keyboard, and the various hallucinations are triggered either by proximity to objects, by pressing keys, or randomly. The scene parameters, and object filenames, positions, orientations and properties are read in from a configuration file, so that the scene layout or properties can be changed without re-compiling the program.

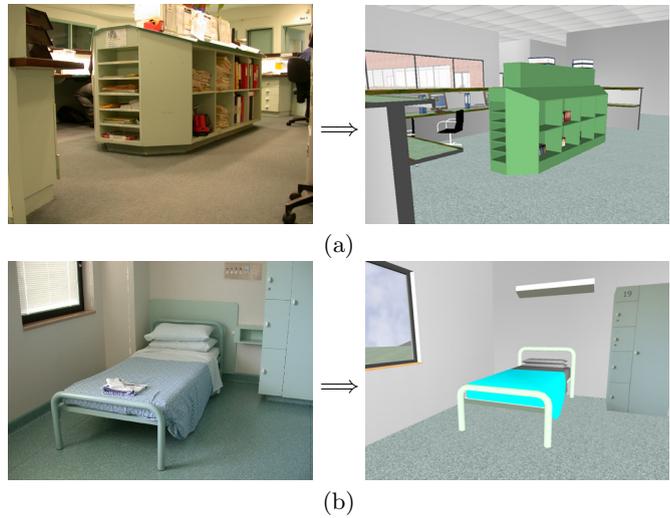The software was written in C/C++, in conjunction with an open source, cross platform scene graph technology.

(a)

(b)

Fig. 3. Actual psychiatric ward and model (a) reception area (b) bedroom.

Why Scene Graphs? A scene graph can be used to improve the efficiency of rendering of large, complex scenes. Objects are comprised of polygons, which need to be rendered by the graphics pipeline. For large, complex scenes, it is often the case that only a small part of the scene will be visible on the display device at a time, or that many polygons will be occluded from view. In such cases, it is a waste of time to render polygons which are not visible.

A scene graph organises objects in a hierarchical tree-like structure called a Directed-Acyclic Graph (DAG), where objects are usually grouped according to their location in the scene. If a node in the graph is found to be not visible, then all child nodes of this node can be removed from the rendering pipeline, thus improving efficiency.

In addition, many scene graphs also provide useful tools such as: object tools (reading in different file formats, transformations, rendering properties, animations); built-in primitives (eg, rectangles, spheres, polyhedra, text); and viewing tools.

For this version of the software, the OpenSG scene graph was chosen, as at the time it seemed to provide an adequate built-in viewer and was able to read in the VRML object files exported from Realax. However, it did not automatically read in animations, therefore these needed to be programmed in C++ code.

The Virgin Mary The most challenging hallucination in this psychosis simulation was the vision of the Virgin Mary. This was implemented as a 2D movie projected onto a billboard, since it meant that only one extra polygon would be added to the scene, and it also enabled a translucent halo to be easily added.

The Virgin Mary sequence was filmed using an actor dressed in robes, and the background set to transparent. A separate program was written to preprocess the movie and add a golden halo around the Virgin Mary figure. The alpha values were gradually decreased from the edge of the Virgin Mary figure to the edge of the halo, so that the halo would become progressively more transparent towards the edge. A darker halo was used for the "abusive" Virgin Mary.

Code was then written to read in the movie from the saved file, and then display each frame on the billboard polygon, at the required frame rate and synchronised with its audio.

Sound and Video Implementation The auditory hallucinations and Virgin Mary movie were implemented using the SGI Audio, Audio File, and Digital Media Libraries (under IRIX, consult the man pages for "alIntro", "afInto" and "dmIntro" for detailed information on usage). When a sound or movie is played, a separate program thread is generated. This is in order to make efficient use of the Onyx's four processors. Also, once an audio or movie thread is initiated, it merely has to play to completion and does not need to communicate with the main program. Therefore in this case the use of multiple threads does not introduce a significant overhead.

The audio hallucinations can be triggered by proximity to a certain object (such as the stereo, in the case of the political speech), or they can play at random intervals as one navigates through the virtual scene. This gives the effect of many different voices interjecting and speaking at once.

5   Patient Feedback

The patient was very positive about the simulation, stating "It's just such an extraordinary experience", and "It was quite a good approximation capturing the essence of the experience." She particularly liked how the visions and voices were interlinked and were played over one another, and that it effectively re-created "the sensation of a lot going on in your head", and showed "how difficult it is to retain reality or grasp on reality when you're in those spaces, because you're so distracted by what's going on around you."

She patient also stated that the way that the hallucinations repetitively made the same comments accurately reflected her experience of psychosis. "The fact that they went on and on and people would think, 'My God, why can't they turn them off?' ... it just shows how they go on and on – and how you can't just step out of the room and get away from them." She commented that the simulation was also effective in re-creating the same emotions that she experienced on a day-to-day basis during her psychotic episodes. She hoped that it would give viewers an inkling of "how disjointed and absolutely terrifying and harassing voices are", and show "how undermining they [the hallucinations] are of a person. ... and as you're sitting there for the half hour watching it, by the end of the half hour you might start believing yourself that you are evil."

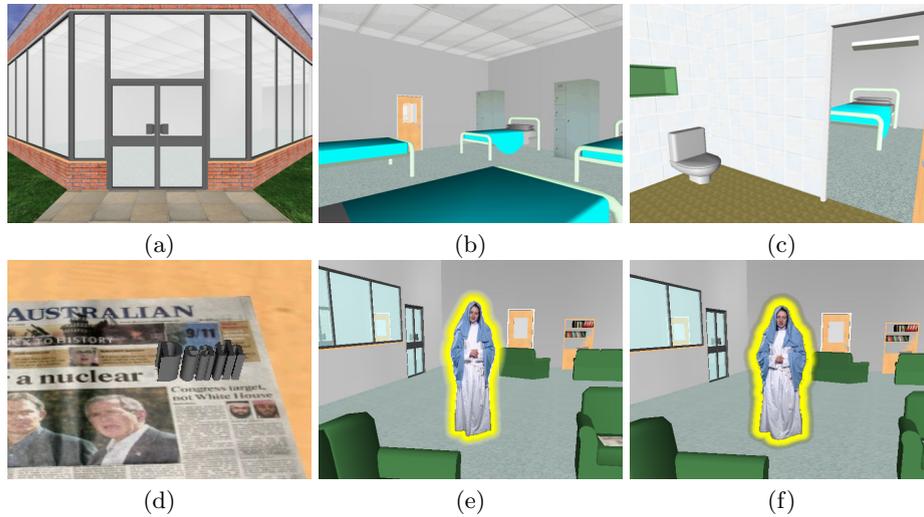More detailed information on the patient feedback can be found in [7].

Fig. 4. Views of the psychiatric ward and hallucinations: (a) front entrance; (b) bedroom; (c) bathroom; (d) "death" hallucination; (e) Virgin Mary hallucination; (f) "abusive" Virgin Mary hallucination.

6 Psychosis Simulation Environment – Version 2.0

The next phase of the project will implement the hallucinations of further patients. A second patient has already been interviewed, in a similar manner to Patient 1. The hallucinations of Patient 2 which have been selected to be implemented include the following:

1. Auditory hallucinations, usually derogatory or abusing the patient, or telling the patient to kill themselves.
2. Bagpipe music.
3. Reflection of the patient in the mirror becomes grey and drawn.
4. Signs on the wall morph to spell abusive or obscene words.
5. The word "fascism" stands out of book titles.
6. A policeman's gun becomes emphasised, and voices tell the patient to take the gun and kill themselves.
7. The floor becomes covered with "clouds", with only sections of floor visible as "stepping stones".

It is planned to add these hallucinations to the existing psychiatric ward model.

6.1 Scene Graph Evaluation

It is envisaged that improved frame rates can be achieved by selecting a different scene graph as the basis for implementing this application. In order to make the best decision we are currently undertaking an evaluation of six different scene graphs. The criteria of evaluation include:

– frame rate
– cross platform capability
– ease of programming
– spherical mode support (for the VISAC laboratory)
– future development of scene graph, support available
– licensing issues
– ease of audio / video integration
– provision of built-in viewer functionality such as collision detection, navigation, proximity detection and picking.
– provision of built-in effects such as simple animation, lighting, level of detail, fog, particles, reflection and shadow.

In addition, we will investigate increasing the level of realism in the scene through the use of techniques such as soft shadowing, higher quality textures, and dynamic lighting.

6.2 Implementation Platform

Version 1.0 of the software was developed on the IRIX platform for the VISAC laboratory. However, future versions of the software will need to be ported to a PC platform such as Linux or Windows. This will enable the software to be used, for example, in a psychiatrist's office or a hospital, making it more accessible to potential users such as patients, caregivers and mental health workers. Therefore, it is important that the scene graph and any other libraries that are used in this application are cross platform.

It was anticipated that the audio and video interface would need to be re-written for each platform. However, we are investigating using the open source, cross platform SDL (Simple DirectMedia Layer) libraries (http://www.libsdl.org/).

7 Conclusion

This paper has described the development of a virtual environment which simulates the auditory and visual hallucinations of psychosis. The hallucinations of one particular patient were re-created in a model of a psychiatric ward.

After viewing the simulation, the patient was quite impressed and commented that it effectively re-created the same emotions that she experienced on a day-to-day basis during her illness. This is important if the virtual psychosis environment is to be used as an educational tool about psychosis.

It is expected that the use of the virtual psychosis software in the classroom will develop in students a greater empathy for the mentally ill. Further research will be conducted to determine if this is actually the case. The research will explore student and lecturer expectations of VR, how it is used in the classroom, and how it impacts on education in terms of increased understanding of psychosis and improved educational outcomes.

A long term goal of this work is to test its clinical potential as a tool to be used in cognitive behavioural therapy (CBT) [5]. In this, a study would compare patients who receive traditional CBT to those who receive VR enhanced CBT.

A goal even further into the future is to enable patients to re-create their experiences in conjunction with their therapist. This would require that both the models and the hallucinations, auditory and visual, are able to be edited at run-time.

The current state of the software development is that we are in the process of improving the efficiency and realism of the software, porting to a PC platform, and implementing the hallucinations of Patient 2. We are currently undertaking an evaluation of six different scene graphs, in order to select the one best suited to this application.

It is hoped that this work will result in a useful educational tool about schizophrenia, which will lead to improved training of clinicians, and foster improved understanding and empathy toward sufferers of schizophrenia in the community, ultimately improving the quality of life and chances of recovery of patients.

Acknowledgements

References

1. Empathy as evoked by virtual reality technology progress report: Phase 1. UMEÅUniversity VR Lab, Technical Report, August 1999.
2. L. Hodges, P. Anderson, G. Burdea, H. Hoffman, and B. Rothbaum. Treating psychological and physical disorders with VR. *IEEE Computer Graphics and Applications*, pages 25–33, Nov/Dec 2001.
3. Kaplan and Sadock. *Comprehensive Textbook of Psychiatry, vols. 1–2.* Lippincott Williams & Wilkin, Philadelphia, 7th edition, 2000.
4. B. Rothbaum, L. Hodges, D. Ready, K. Graap, and R. Alarcon. Virtual reality therapy for Vietnam veterans with post traumatic stress disorder. *Journal of Clinical Psychiatry*, 62(8):617–622, 2001.
5. T. Sensky, D. Turkington, D. Kingdon, J.L. Scott, J. Scott, R. Siddle, M. O'Carroll, and T. Barnes. A randomised controlled trial of cognitive-behavioural therapy for persistent symptoms in schizophrenia resistant to medication. *Archives of General Psychiatry*, 57(2):165–173, 2000.
6. J. Tichon. Enhancing experiental learning via virtual environments. In *World Conference on Educational Multimedia, Hypermedia and Telecommunications*, Honolulu, Hawaii, June 2003.
7. P. Yellowlees, S. Jeffs, J. Banks, G. Ericksson, D. Fernandez, J. Tichon, and K. Burrage. The subjective comparison of real and virtual psychotic experiences. Unpublished manuscript.