

Chapter 21

The Senses Beyond: New Directions in Game Engine Experiences

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Abstract. Video games are a significant part of audio-visual culture, and game engines are widely used not only for the construction of video games, but also arts projects, virtual reality experiences, and serious or educational games. This chapter presents a series of short summaries which describe student projects produced on the games and digital media BSc degree programmes at the University of Greenwich. These projects indicate interesting new directions in game engine experiences, and contribute towards emerging strands of practically-focused research in video games. Each project has involved background research into related literature and artefacts, which then informs the design, development and evaluation of a prototype product. The projects discussed here specifically explore themes related to adaptive music; representation of animal species; retro aesthetics; the design of artificially intelligent game characters; and the representation of hallucinations or intoxicated states in games. As a collection there are some common themes, and the projects collectively point towards novel ways in which game engines may generate experiences that activate the visual and auditory senses in ways that elicit empathy, emotions, memories, and awareness of unusual sensory states and systems.

Introduction

Video games are prolific in modern culture, having steadily grown to in excess of 44 million users in the UK, and 4.7 million pounds in sales revenue in 2022 (Statista 2023). The games industry uses various bespoke tools and game engines to create these products, as well as video game engines such as Unity and Unreal Engine. These game engines can be used for creating various games ranging from 2D mobile video games to 3D console games and virtual reality experiences. In essence they allow the user to combine 2D or 3D graphics with programming via the use of scripts, which allow various mechanics and behaviors to be designed as required for the project in hand. Both Unity and Unreal Engine can be freely used for non-commercial projects, which makes them readily accessible tools to use in education.

Whilst the primary use-case of game engines is, of course, video games as entertainment software, game engines are also now widely used in many other areas and industries including the arts, serious games such as training simulations, and animations for film and TV. To give an example of this, in my own work I have been particularly interested in music visualisations, and elsewhere I have discussed the use of game engines for generating immersive music experiences using technologies such as mixed reality (MR), virtual reality (VR), and others (Weinel 2020). Music festivals such as Lost Horizon (2020) have used video game engines to provide networked experiences where users can remotely explore a virtual festival environment with stages, lightshows and performances, whilst socialising with other avatars in the virtual environment. Examples such as this take advantage of the 3D interactive capabilities of game engines to generate virtual environments and experiences, which don't necessarily require ludic elements. They also point towards possible future uses of networked game engine experiences for leisure and creativity, which we may see more of in the socially connected virtual worlds of the metaverse.

For a number of years I have been exploring this area through my own projects such as *Cyberdream* (Weinel 2021), a psychedelic rave music experience in virtual reality. However, alongside this I have also been teaching modules in various areas of game audio and video games development, most recently at the University of Greenwich on the game and digital media BSc degree programmes. In this context I have designed several modules with assessment briefs that give students scope to experiment with the use of game engine technologies for creating interactive experiences. The projects that students create on these modules may be video games, but can also be virtual experiences addressing various topics, sometimes including game-like elements in virtual environments.

As undergraduate projects at level 6, these are not formally required to propose new approaches or contribute to the development of new techniques — this is the domain of master's and PhD research at levels 7 and 8 (QAA 2014). Nonetheless, they are produced by students deeply immersed in games culture and development, putting them very much at the centre of a particular area of arts and computational culture, and often intimately aware of

the latest tools and trends. Perhaps because of this, their projects often indicate interesting new ideas and directions. University provides a context where novel project ideas can flourish without the constraints of commercial briefs and client requirements, which can sometimes allow room for blue-sky experimentalism that leads to interesting outcomes, which is worth reporting. Some of this work may suggest new approaches within gaming, and some of it may also implicate the use of games in new areas and for different audiences. Dissemination is possible through end of year degree shows or online student portfolios, however in recent years I have also supported several students to present their work as papers/demos in a research context at the conferences *EVA London (Electronic Visualisation and the Arts)* (see: Holtum 2020; McIntosh 2021; Pyjas, Weinel & Broadhead 2022; Tsjornaja, Weinel & Broadhead 2022; Lawal, Weinel & Gent 2023; Rodney, Weinel & Broadhead 2023) and *ACM Audio Mostly* (McIntosh, Weinel & Cunningham 2023). These published papers have been subject to the same academic peer-review processes as professional academics and researchers, and the reviewers have recognised the innovative aspects of the projects. Thus, while these papers should very much be considered as ‘early work’, they do reflect original contributions to the research discourse in games, particularly because in most cases there is not much in the way of other practically-focused research in video games development that is actually discussing the topics they are looking at.

In further consideration of where this work fits in the spectrum of video games research, it is useful to consider the new Video Games Research Framework (Gov.uk 2023) published by the UK government in May 2023. This framework emerged in recognition of the need for research into video games, which since the 1970s has grown into a major area of the UK economy, contributing an estimated £2.8 billion to the UK economy in 2019. Despite having been around since the 1970s and served by many industry and trade conferences, video games have not been well-served by academic research until fairly recently. For instance, while initiatives such as the Digital Games Research Association (DiGRA) have been around since 2003, many academic journals focusing on this area only began in the last ten years; for example, *IEEE Transactions in Games* started in 2018. Games is then a fairly young field in academic research, and there are many areas and discourses that have not yet been explored. The Video Games Research Framework reflects an overdue awareness and recognition of video games as an important industry, art form and cultural phenomenon in the UK that is in need of academic scrutiny. Yet, the framework itself focuses more on trying to understand the impact of video games culture in society. Though this is no doubt important in itself, the framework seems to overlook the potential for practically-focused academic research that could actually contribute towards new ways of designing the architecture and mechanics of the games *themselves*, from both creative and technical perspectives. That is, games and game engine technologies have many untapped potentials; we can extend what we can do with game engines; reimagine what is possible; or repurpose the tools for other areas where they have not been used before. The student projects I have supervised fit into the latter area, reflecting novel strands of enquiry with an emphasis on practical techniques, which could provide valuable building blocks for further research in games at the frontiers of arts and computational culture.

With this in mind, and following on from the publication of the individual papers, for this chapter I have compiled a selection of student projects that I have supervised from 2021–2023, in order to make the novel concepts and direction these projects point towards accessible to the wider research community working with game engine experiences. Each project summary outlines the main outcomes of an investigation undertaken as a student research project. These projects begin with background research into relevant literature and case studies, which then informs the design and development of a product prototype. These projects all use game engines and relate to aspects of the user experience. Beyond the visual and aural, these projects allow us to consider how game engine experiences may give rise to empathy and emotion; evoke memories or nostalgia; promote engagement; or communicate unusual forms of sensory experience. In what follows, projects will be discussed which explore themes such as adaptive music; representation of animal species; retro aesthetics; the design of artificially intelligent (AI) game characters; and the representation of hallucinations or intoxicated states in games.

Adaptive Video Game Soundtracks

Music is a vital component of video games, and many of the latest titles use adaptive soundtracks which change based on parameters and events during play (Collins, Kapralos & Tessler 2014). This is often facilitated using game audio middleware software such as Wwise (AudioKinetic 2023). In a project by Virginia Eirini Tassopoulou, she explored the use of Wwise for generating an adaptive soundtrack in the context of an original 2D platform game, specifically looking at the emotional impact of the music for the user. The background work for this study explored different approaches for organizing the musical material, such as vertical layering systems in which layers of the music composition are added or subtracted depending on events and progression in the game; and horizontal resequencing, where the order of musical elements in the composition changes based on

player actions or events (Sweet, 2014). Research regarding the role of music in inducing player emotion was also reviewed, which points towards a significant impact on players in terms of their sense of tension, suspense and excitement, which can influence player mood and behavior (Joosten, van Lankveld, & Spronck 2010; Meyer 2018).

The prototype product for this project consisted of a platform game with original graphics and sounds (Fig. 21.1). The game provided four different areas with different graphical themes and colour schemes. An original score was composed for the project using Ableton Live, with different sections designed to provide varying moods for the four areas of the game. In the final version, sound and music were implemented using Wwise, and the music fades seamlessly between the different sections as the player moves between them in the level. This is accomplished using a crossfade effect, and the music remains in synchronization throughout. Sound effects were also implemented using Wwise for aspects such as footsteps and collectable items.

A survey was devised with the intention of measuring participant responses to the sound effects and music. This was deployed to give some feedback on the game audio experience. This suggested some areas for improvement such as balancing the levels between sound effects and music in different parts of the game. In general participants responded positively to the emotional impact of music in the game, however it was noted that further work would be needed to explore how these emotions may have changed during the four different sections of the game. There is other existing work looking at music and emotion in video games and this project retreads some familiar territory, but also finds some novelty in the implementation and attention to different audio-visual relationships with the original sound and 2D pixel-art graphics.



Fig. 21.1 Screenshot from Virginia Eirini Tassopoulou's project, which explored the effects of adaptive soundtracks on player emotion.

User Engagement in VR Music Festivals

A project by Agustin Alonso Fernandez Quintanilla explored the design and development of a VR application based on a fictional music festival, with the aim of producing an application that would promote user engagement. The background research for this project explored research around VR and virtual worlds, which informs approaches for usability such as creating appropriate navigation interfaces (Castronova 2008). Alongside this, the project looked at aspects such as spatial audio in VR; 3D character animation techniques; and the use of software such as PolyCam (2023); FaceBuilder for Blender (Keentools 2023); and MetaHuman (Unreal Engine 2023) for generating characters that incorporate 3D scans of real faces. Related products such as the Tomorrowland Around the World digital festival (Tomorrowland 2021); *Wave Beta VR* (Wave 2018), and *Lost Horizon* (2020) were

explored, all of which indicate existing approaches where game engines have been used to create virtual music experiences.

The background research informed the design of *ThasFest*, a VR music festival experience based on a fictional festival concept. The product was created in Unreal Engine 5, and incorporated a 3D environment with a festival entrance and security checkpoint; several stages with animated characters, music and lights (Fig. 21.2); food trucks, merch stalls and funfair attractions. Whilst it was beyond the scope of this project to make a networked version of the experience, it was designed with the intention that it could provide the basis for a metaverse application in VR, where users could customize avatars to represent themselves in the festival. In consideration of this, the project adopted a low-poly style, and utilized FaceBuilder for mapping 3D scanned imagery on to the faces of animated characters in the project.

User testing of *ThasFest* was undertaken with a small group of ten participants using the short form version of the User Engagement Scale questionnaire (O' Brien, Cairns & Hall 2018), with an additional free text question. This pointed towards some areas for improvement, such as implementation of additional tutorial information; additional focal points in the virtual environment; and navigation shortcuts. Notably there were some challenges for this project in using the latest version of Unreal Engine with VR, and some additional work would be needed to further refine the project. Nonetheless, in general the prototype was a success, in particular pointing towards a new design approach whereby real-world faces could be implemented on character avatars in a 3D music festival experience – something we may well see more of in future metaverse applications.



Fig. 21.2 Screenshot from *ThasFest*, a VR experience in which the player can explore a fictional music festival.

Serious Educational Games for Animal Welfare

In her innovative project ‘Through the Eyes of a Virtual Parrot: Animal Welfare in Serious Educational Games’, Zsanett Alexandra Mazumel created an interactive experience that aims to promote awareness of animal welfare issues for parrots. This project falls within the domain of serious or educational games, which aim to educate rather than entertain (Gorbanev et al., 2018; Zhonggen, 2019). The background research for this project explored ways in which games such as these may generate a sense of empathy towards different groups by giving insights into their thoughts, views, or physical perspectives, thereby leading to long-lasting and impactful interpretations of others (Shibuya et al., 2019; Hekiart, Igras-Cybulska & Cybulski, 2021; Hekiart et al., 2022). Following work in this area, the project proposes that representing the experiences of a parrot from a first-person perspective in a short interactive experience may provide a means to increase empathy, and awareness of animal welfare issues for parrots. The project also looked at existing games that represent animals, noting in particular negative

representations of animals which are often killed for fun or to gain resources, as in games such as *Red Dead Redemption* (Rockstar Games 2010).

Informed by this background research, *Parrot Simulator* was developed in Unity which provides a short interactive narrative, where the player takes on the role of a Hahn's Macaw trying to escape from captivity. In the game menu, other parrot types are intentionally marked as 'unavailable' due to either being endangered (Kakapo, Military Macaw, African Grey) or extinct in the wild (Spix Macaw). In the game, the player takes the role of a parrot escaping from captivity in a run-down shack (Fig. 21.3). A window in the shack is indicated as a target destination, but when we attempt to fly through it, the parrot collides with the invisible glass and falls to the ground stunned. Eventually through further exploration, we can escape, but the game ends with a cautionary message that many wild parrots are often less fortunate, highlighting the effects of deforestation, predation and illegal trading of parrots.

A small scale evaluation with thirteen participants was carried out with a survey using a 5-point Likert scale (a type of psychometric rating scale) and questions designed to investigate various aspects of the user experience such as the player sense of control, challenge, feedback, autonomy and emotional involvement in the game. This helped inform some areas for technical improvement in the design of some aspects of the player interaction and instructions, though the outcome was broadly positive. With games now such a ubiquitous part of modern culture, *Parrot Simulator* shows a new and specific example of how they can be used as interactive narrative devices that tell stories that carry a serious, educational message that could have a positive impact in society.



Fig. 21.3 Screenshot from *Parrot Simulator*, in which the player takes the role of a Hahn's Macaw parrot trying to escape from captivity.

Representing Amphibian Perspectives in Games

Raheem A. Lawal's project investigated the representation of amphibians in a 3D game engine, focusing in particular on the Texas blind salamander (Lawal, Weinel & Gent 2023). The background research for this project investigated the sensory experience of the Texas blind salamander which lives in aquatic caves and eats snails, shrimp and amphipods (Geraldson & Haas 2014). Whilst it cannot see, it senses its prey by detecting changes in water pressure with its body. In considering possible ways to transmit these unusual sensory modalities into the graphics and sound of a 3D game engine, the project looks at various possibilities such as haptic feedback 'rumble' technologies, graphical and sound techniques. For example, some existing video games such as *Perception* (Deep End Games 2017), *Alien vs Predator* (Rebellion 2010), and *Metroid Prime 2: Echoes* (Retro Studios 2004) use various techniques involving shaders, particle effects, postprocessing, user interface (UI) elements, and sounds to communicate unusual forms of sensory perception for the user. In general, a translation between the sensory

modalities is often used, so that non-visual or non-aural forms of awareness are represented in the game using distinct visual or auditory features.

Informed by this background work a product prototype was developed, which consisted of a first-person character control system for a Texas blind salamander in a cave environment. The game demo takes place in an aquatic cave environment made up of rocks and terrain, which are rendered as outlines using a rim-light shader, which illuminates only the edges of objects (Fig. 21.4). This provides the user with a monochromatic outline of the space. As the salamander hunts, its prey gives off pressure waves which are generated using particle effects. When detected, a UI element gives an indication of direction, and a rumble is felt on the gamepad. As the player gets nearer to the target, a shader effect makes the prey visible to the user as a glowing white oscillation. When the player is close, they can launch an attack to eat the prey.

The prototype was evaluated by a small group of participants using the Game User Experience Satisfaction Scale (GUESS), a validated survey focusing on user experience (Phan, Keebler, & Chaparro 2016). This gave an initial indication that the approach was broadly effective, whilst also informing areas for future improvement such as clearer player guidance on the control system; development of the hunting system to provide a specific goal (e.g. catching a certain amount of prey); improved models, animations and AI movement for the prey. It was also noted that improved use of the directional capabilities of the PS5 DualSense haptic feedback could be provided in the future to enhance the experience. The project shows an original method of representing the sensory experiences of amphibians using game engines. More generally, it also shows how the audio-visual features of game engines can be used to translate unusual sensory experiences into a format that is appreciable for the user, and in particular also highlights how haptic technologies can be used for this purpose. In the future, we may see more game engine experiences of this kind, which allow us to experience virtual worlds through the senses of many creatures.

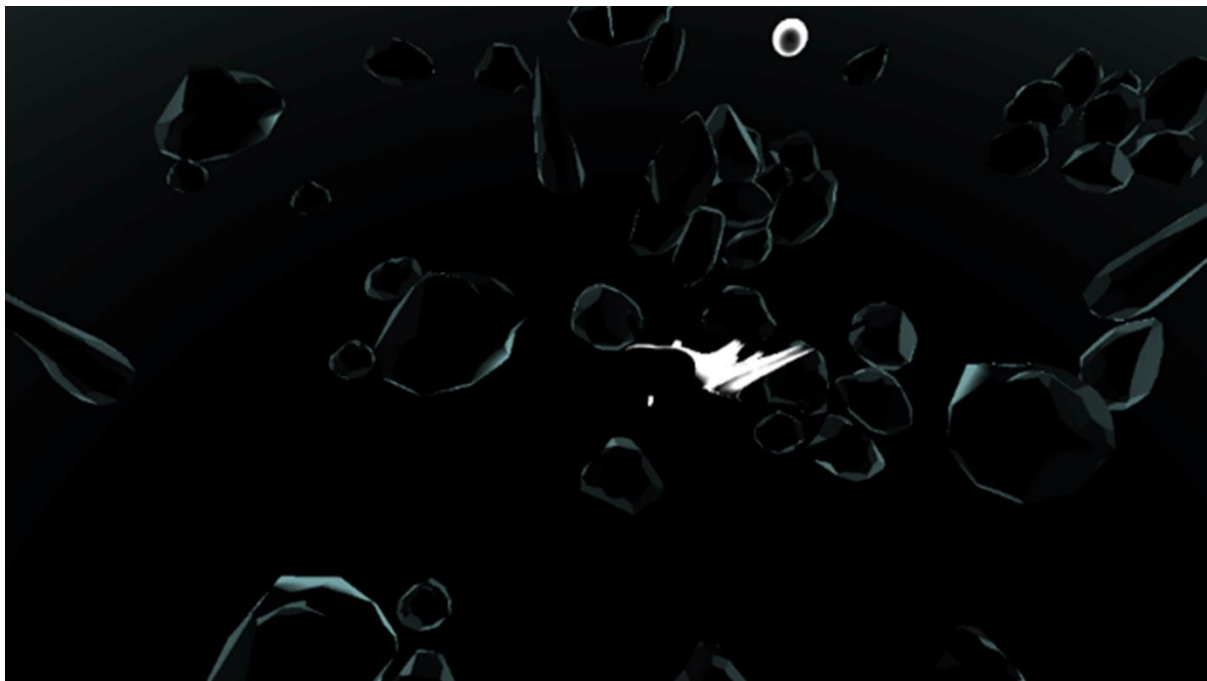


Fig. 21.4 Screenshot from Raheem A. Lawal's project, in which shaders and particle effects are used in combination with haptic 'rumble' features of a game controller to give the player an impression of life as a Texas blind salamander hunting its prey in an aquatic cave system.

Designing Experiences of Nostalgia in Games

Chloe Maybank chose to investigate design features of new retro games that might give rise to nostalgic experiences. Modern video games culture includes many retro titles, which include emulations of games from older systems, and games that are designed using retro stylistic features such as pixel art or chiptune music. Exploring this area, the background research for this project looked at definitions of nostalgia (Harborth and Pape, 2020), and how these might be implemented in retro video games that would provide technological acceptance in terms of perceived usefulness and perceived ease of use (Davis 1989; Lee, Kozar & Larsen 2003; Marangunić

and Granić 2014). To investigate key features that define various kinds of retro aesthetics in games, the project also examined systems such as the Game Boy, SNES and PlayStation 2, considering aspects such as screen resolution, colour pallet, and audio capabilities.

For the product prototype, a side-scrolling platform game entitled *Retro Gaming Nostalgia* was developed in Unity, which incorporated jumping mechanics and collectable items. The game demo provides three iterations of the same game, adapted to incorporate the graphics and sounds based on those of the Game Boy, SNES and PlayStation 2. Each version takes into consideration the visual and sonic aesthetics of the respective systems, thereby providing different variations of the same retro gaming experience. For instance, whilst the Game Boy version uses the limited green colour palette from that system (Fig. 21.5), the SNES version uses an enhanced colour pallet, and the PlayStation 2 version uses 3D graphics providing a ‘2.5D’ version of the game.

A small-scale evaluation tested each game with a survey that queried users about their experience of nostalgia. The results suggested that all three games were broadly perceived as nostalgic, suggesting that any of the aesthetics of any of these retro systems may be broadly perceived as nostalgic for users. While further work would be needed, for the participants of the study, the results may point towards the idea that there are now many subtypes of retro aesthetics in games, which are closely related to the hardware capabilities of various systems. Often when we think of retro games, we think of early 2D gaming systems, but it in modern games culture there is an increasing awareness that earlier 3D graphics of the type seen on more recent systems such as the Sega Dreamcast, Sony PlayStation 2, or Nintendo Wii are also now considered ‘retro’. These aesthetics are often desirable for users, and we may anticipate that the gaming experiences of the future will continue to look to the past for inspiration.

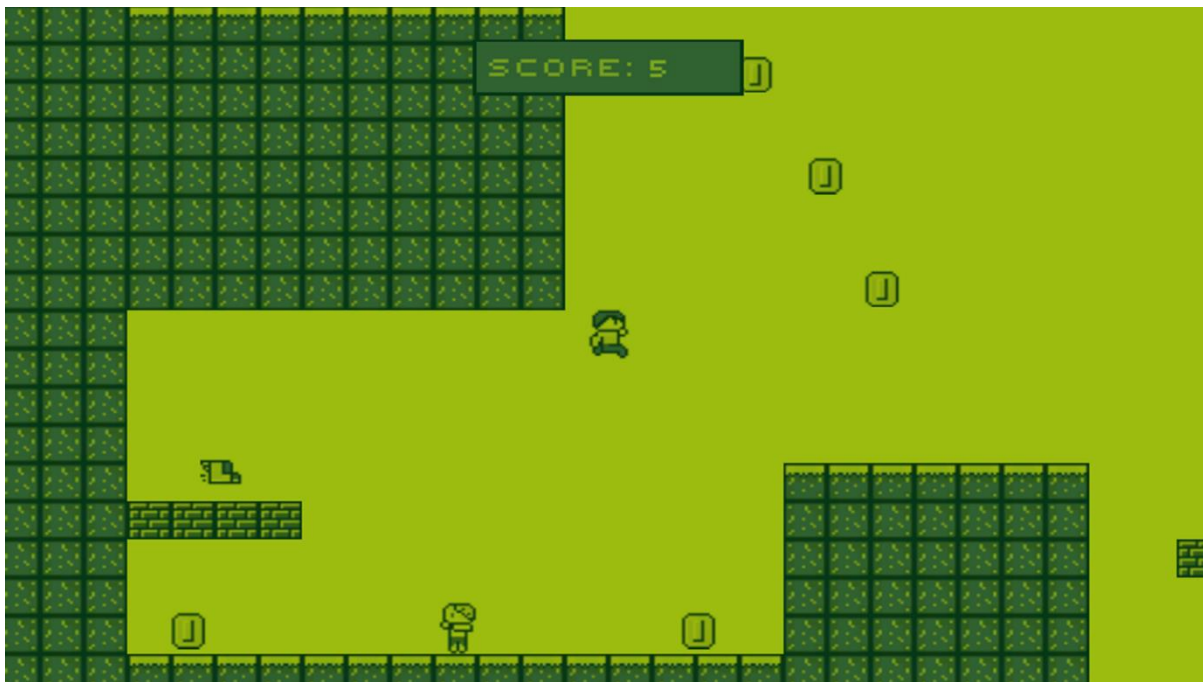


Fig. 21.5 Screenshot from the Game Boy mode of *Retro Gaming Nostalgia*, in which a 2D platform game is played with graphics and sounds based on the Nintendo Game Boy.

Retro Stylistic Transformations in Games

In Ross Rodney’s project on retro stylistic transformations in games, he examines a specific phenomenon that is found in various contemporary games, whereby key sections of the game allow the user to switch between modern and retro viewpoints. The function of such features relates to nostalgia, which for the purposes of this project is considered in relation to Garda’s (2013) discourse on the topic, in which ‘restorative’ nostalgia describes one-to-one recreations of past video game experiences; whilst ‘reflective’ nostalgia generates new gaming experiences based on the graphical and sonic limitations of past systems, which give rise to distinct aesthetics. It is within the latter that games such as *Super Paper Mario* (Intelligent Systems 2007), *Adventures of Pip* (Tic Toc Games 2015) and *Mario Odyssey* (Nintendo 2017) are located, which in various ways incorporate retro aesthetics in modern contexts. For instance, *Mario Odyssey* is a recent iteration of the Mario franchise which is predominantly realized

with modern 3D graphics, yet features sections where classic 2D sprite-based graphics, gameplay, and chiptune audio are temporarily used in mini-games. Where sections such as these occur, graphical and sonic transitions can be used to modulate between modern and retro graphics, and it is the design of these transformations that Ross Rodney's project focuses on.

For Ross Rodney's prototype, a third-person perspective platform game was designed in Unity, where the user can switch between 2D and 3D modes in real-time. Technically this is accomplished by moving between 3D perspective and 2D orthographic views with a smooth transition between the two cameras. In 3D perspective mode, the camera follows the player character from behind. When the retro toggle is triggered, the view sweeps to a side-view 2D orthographic camera (Fig. 21.6). In this 2D orthographic retro view, the game character is rendered as a 2D sprite and we see the background rendered using parallax cloud effects. Post processing is also used to emulate the curvature and look of a CRT television. In tandem with this, a cross-fade effect is used to morph the soundtrack into a retro lo-fi version of the same music. The transitions are not only cosmetic, but also allow for the implementation of an interesting game mechanic, whereby navigation of some platforms requires the use of either the 2D or 3D view, and the switch must sometimes be made in mid-air whilst jumping.

A small group of participants evaluated the product using the GUESS questionnaire (Phan, Keebler, & Chaparro 2016), with some additional questions to address the retro transformations specifically. The results of the user study tentatively indicate that the game was broadly enjoyable, with most questions scoring highly, though areas for improvement in play guidance on how to play could be improved. Most users seemed to enjoy the retro transformations and did not find them too disorientating, which suggests that the transitions between 3D and 2D were broadly successful in this project. Some additional changes were made following the user feedback in order to provide additional UI features to indicate how to trigger the transformations and which direction to go during the wall climbing sections. The incorporation of retro aesthetics is widespread in many types of games, and this project has shown a novel approach for designing these as temporary transformations which are blended seamlessly and integrated into gameplay. The innovation of this project arises because the project demonstrates a new mechanic for exploring these, transformations (both in terms of the transformation itself, and the gameplay implementation); shows ways that these transformations can be tested/evaluated; and explicates a project in this areas within a research context, which opens up new pathways in games research that has a practical focus, providing a theoretical basis for other work like this in the future.

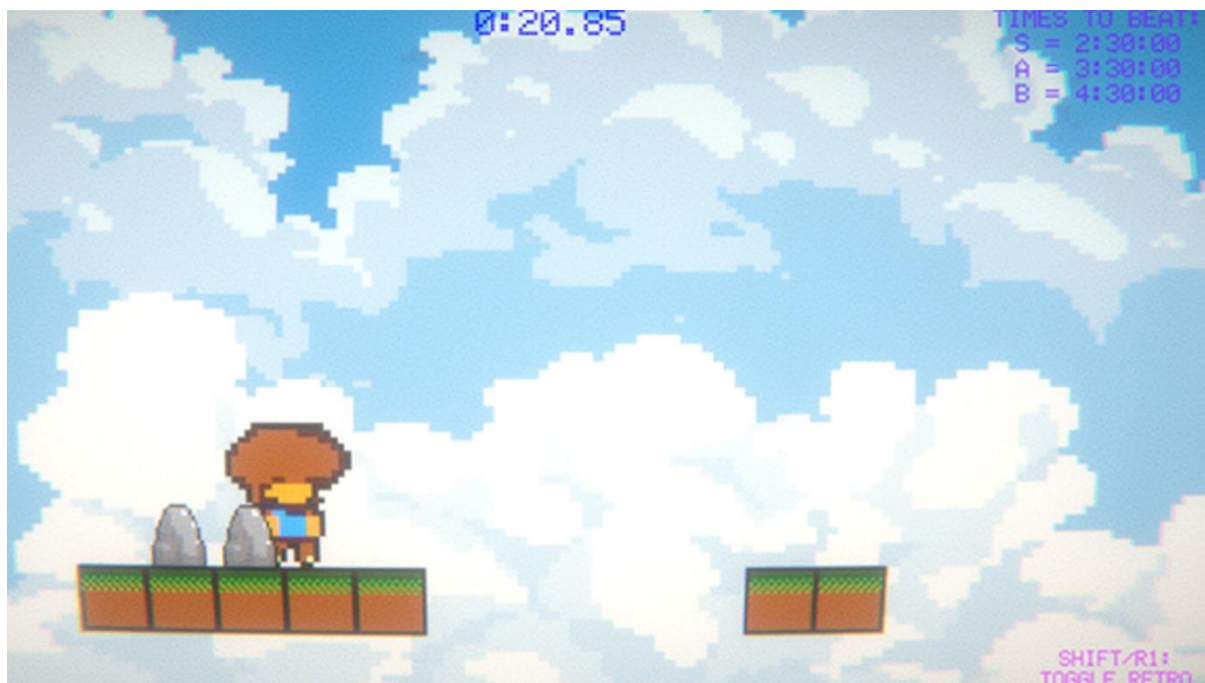


Figure 6. Screenshot from *Retro Stylistic Transformations* in 2D orthographic view.

Fig. 21.6 Screenshot from Ross Rodney's project on retro stylistic transformations, in which the player can switch from 3D into the 2D view shown here, which imitates retro graphics and the curvature of a CRT television.

Needy Non-Player Characters

Exploring ways to enhance the believability of non-player characters (NPCs), Francisco Joaquin Bas Alonso developed a *Goal Oriented Action Planning* demonstration town where character behavior is dictated by current needs such as hunger or sleepiness. In the context of video games, the concept of AI most commonly relates to the design of NPCs that seem to behave in believable ways. This is typically facilitated through the use of techniques involving ‘finite state machines’ or ‘behaviour trees’, which allow behavior states and animations to be triggered depending on pre-defined conditions during play (Johnson and Wiles 2001; Yannakakis & Togelius 2018). Investigating this area, this project focused on a specific technique known as Goal Oriented Action Planning (GOAP) (Hoang, Lee-Urban & Muñoz-Avila 2021), whereby characters act based on specific goals, as previously used in games such as *F.E.A.R.* (Monolith Productions 2005). The background research also looked at Maslow’s (1943) hierarchy of needs, a model from psychology which considers motivating factors that may influence human behaviour.

The prototype for this project consisted of a small town populated by NPCs who have various jobs to do, and must carry out tasks such as going to the market, collecting food, or restocking food (Fig. 21.7). The NPCs each need regular sleep, and have energy, hydration and nutrition levels that change during the day and night based on various factors such as the temperature and individual characteristics; for instance, some characters are night owls and prefer to work at night during the day. Following Maslow’s hierarchy of needs, the NPCs will sometimes slack-off on certain responsibilities if they are too hungry and or too tired. In the demonstration, the player can interact with the NPCs by clicking on them, granting requests for items such as food; and may speed up or slow down the time scale so we can see how their activities unfold at an accelerated rate if desired.

To evaluate the project, a survey was designed using 5-point Likert scales with questions designed to gauge the perceived realism of the project in terms of the NPC AI behaviors. The user feedback suggested that some aspects of the demo such as the environment and the ability to of the user to grant resource requests for the characters may have detracted from the perceived realism of the characters and the simulation, however the NPCs were broadly seen as autonomous. The synthesis of Maslow’s hierarchy of needs with GOAP is an original approach demonstrated by this project. Techniques like GOAP are already being used in some games and simulations to create believable NPCs, and it is likely that we will see some interesting leaps forward as systems such as these are integrated with techniques such as those provided by the latest AI Chatbot and Speech synthesis technologies, allowing for the generation of increasingly believable NPC agents, which interact with each other to form complex emergent social behaviors.



Fig. 21.7 Screenshot from Francisco Joaquin Bas Alonso’s project exploring Goal Oriented Action Planning. In a virtual town, NPCs go about their daily tasks, taking into account aspects such as their need for rest, fluids and food.

Inducing Emotions Through AI Characters

The representation of narratives and characters is another means through which games may be able to evoke emotional experiences for the user. A project by Gabriela Maria Pyjas investigated how this may occur through the design of an interactive VR simulation based on real events from the ‘Operation Dynamo’ evacuation of Dunkirk during WWII. The background work for this project investigated discourses on storytelling in VR (Bucher 2018; Ward 2017); theories of emotion (Ekman 1999; Russell 1980); and how these may be applied in games (Calleja 2011). Research on the design of AI and NPCs was also reviewed, with a particular focus on how finite state machines and behaviour trees can be used in games (Yannakakis & Tolegius 2018); and used to design NPCs that represent human emotions (Mozgovoy & Umarov 2012; Caudell & Campisi 2010).

The product prototype for this project consisted of a VR application for the Oculus Quest 2 headset, created in Unity. This project provided a narrative recreation of Operation Dynamo, focusing in particular on a real account given by a soldier, Harry Leigh-Dugmore (Royal British Legion 2022). The project provided a war-torn beach scene with boats, soldiers, aircraft flying overhead, and the sounds of gunfire and falling bombs. Key events described by Harry Leigh-Dugmore are incorporated into the scene, such as soldiers queuing to board the evacuation boats (Fig. 21.8), and cheering as an enemy aircraft is shot down. The soldiers also engage in conversation, and take cover when bombs are dropped on the beach. These AI systems were created using Panda BT (Panda Behaviour 2021), a behaviour tree package for Unity, and the enacted behaviours take into consideration the emotional states of the soldiers.

A small scale evaluation of the project was carried out in order to investigate the emotion recognition and involvement of the users in the VR project. This explored aspects such as identification with the AI characters, and the perceived emotions represented by these. This gave some indication of areas that were successful in terms of the scenario depicted and AI characters, whilst also highlighting some areas for improvement such as implementing improved animations for certain areas and implementing features such as facial animation that were not present in this version of the project. This project shows how the interface of character AI systems such as behaviour trees may be used to provide increased impact in historical educational games in VR, by specifically representing the emotions of characters in the game, thereby showing us not only what happened, but how people may have felt and acted during these events. VR is already being used to communicate historical events in museums, and the use of game engine AI systems could provide interesting ways to further improve these whilst providing enhanced emotional resonances for audiences.



Fig. 21.8 Screenshot from Gabriela Maria Pyjas’s project, which provides a VR simulation based on the evacuation of soldiers from Dunkirk in WWII.

Virtual Hallucinations in Games

Modern video games often feature sequences that represent altered states of consciousness (ASCs), unusual states of awareness where participants may experience heightened emotions or hallucinations of the senses (Ludwig 1966). Daisy Bain's project investigated the design of these states in a Unity game demo. The background work for this project looked at different types of ASCs and the typical forms that these may take. Examples of games that feature representations of ASCs were also reviewed, such as *Grand Theft Auto V* (Rockstar Games 2013) *Far Cry 3* (Ubisoft 2012) and *Uncharted 3: Drake's Deception* (Naughty Dog 2011). These games are among those that represent states of drug use and intoxication, using various combinations of sound, post processing, and changes to the speed or controls of the game.

Informed by this background work, a prototype entitled *Psych Pursuit* was created. This project provided a series of three ASC sequences, whereby the player character is situated in a forest scene from a first person perspective. The player character collects a hallucinogen which precipitates a virtual representation of an ASC sequence, which is implemented in three different ways. Whilst this happens, the player must find and collect coins in the scene. In the first iteration, high contrast bloom post processing effects are used to give blurring effects on screen (Fig. 21.9); in the second, a lens distortion effect is used; and in the third, real-time DSP effects are applied to provide distortions to the aural experience. In each case, the effects are time-variable, which is technically facilitated through the use of graphs (editor curves) which animate properties such as the intensity of the effects over time.

A small-scale evaluation was carried out which asked users to rate the effectiveness of the three ASC mechanisms incorporated in the project. This pointed towards the high-contrast effects as being the most effective for users of the three mechanisms, although in all cases the users also noted some frustration in carrying out the coin collecting task. In some game contexts it may be desirable to make tasks more difficult using ASC sequences, but potential user frustration should also be taken into account to ensure the overall experience remains satisfying. ASC sequences like this are now common in games, but besides my own work in this area using earlier game engines (e.g. Weinel 2011), there has not been much practical research looking at the design and development of ASC scenarios in recent games engines. This project helps us to think how we design these scenarios using modern game engines, providing a foundation for further work which allow us to unpack how and why these sequences are created, whilst refining their implementation to achieve better results.

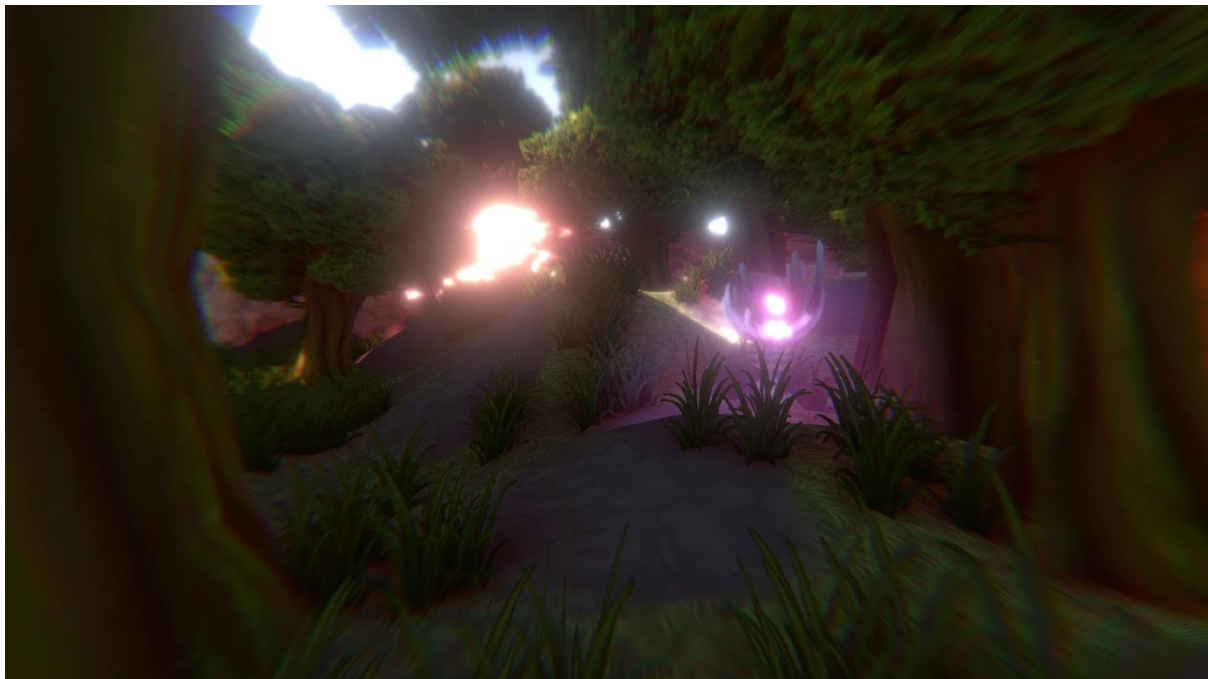


Fig. 21.9 Screenshot from *Psych Pursuit*, in which the automation curves are used to animate post processing effects to represent visual hallucinations.

Hallucinations and Optical Illusions in Games

Also exploring the concept of representing ASCs in games, Max Hegarty developed his own Unity project exploring three different ASC mechanisms. The background work for this project similarly explored features of visual and auditory hallucinations (Weinel 2018), and focused on how optical illusions might be used to represent ASCs in games. A product review looked at various existing titles including *We Happy Few* (Compulsion Games 2016), a game which includes extensive hallucination scenes with endless warped corridors; *Echochrome* (Sony 2008), which includes monochromatic levels that resemble MC Escher drawings; and *Grand Theft Auto V* (Rockstar Games 2013), which includes various graphical effects and narrative sequences depicting hallucinations.

For the prototype, three scenes were designed and developed in Unity, which implement ASC sequences. The first of these was a forest scene with a bridge, where the player must navigate through a woodland to a goal point, where they drink an intoxicating drink, after which they must then walk back to the starting point. The intoxicating drink triggers motion-blur and staggering effects which derail the player controls. In the second sequence, the player moves along a woodland scene where a pathway is lined with trees which appear to scroll past endlessly for a period of time. Camera and fog effects are also used to distort the field of vision and control the visual aesthetics. Eventually the player can navigate to a building where they encounter a corridor, which similarly appears to extend infinitely, while animated camera effects warp the display. In the third and final sequence, we find ourselves suspended in outer space among a network of staircases based on MC Escher drawings (Fig. 21.10). The player must navigate between teleportation points on the staircases which reorientate the upwards direction to create disorientating effects for the player.

A small-scale evaluation used surveys to query player experience on each of the three ASC sequences. The second sequence was broadly considered the most effective by participants. Points for improvement were identified in the implementation of all three scenes, such as refinement of the technical processes used for the visual effects and environments, as well as improving the control systems to avoid bugs and glitches which occurred in some situations. Whilst the prototype showed room for improvement in various technical aspects, the ideas it proposes contribute towards an expansion of ways to represent ASCs within the context of a video game engine. In particular, the use of optical illusion effects which implement distortions to perspective or generate seemingly infinite spaces for the player to navigate is a novel concept here and one that may warrant further investigation. We may expect in the future to see more sequences of this type featured in commercial games, which often implement ASC sequences to enrich narratives and character representations, and will surely be seeking to do these in ever more sophisticated and graphically impressive ways.

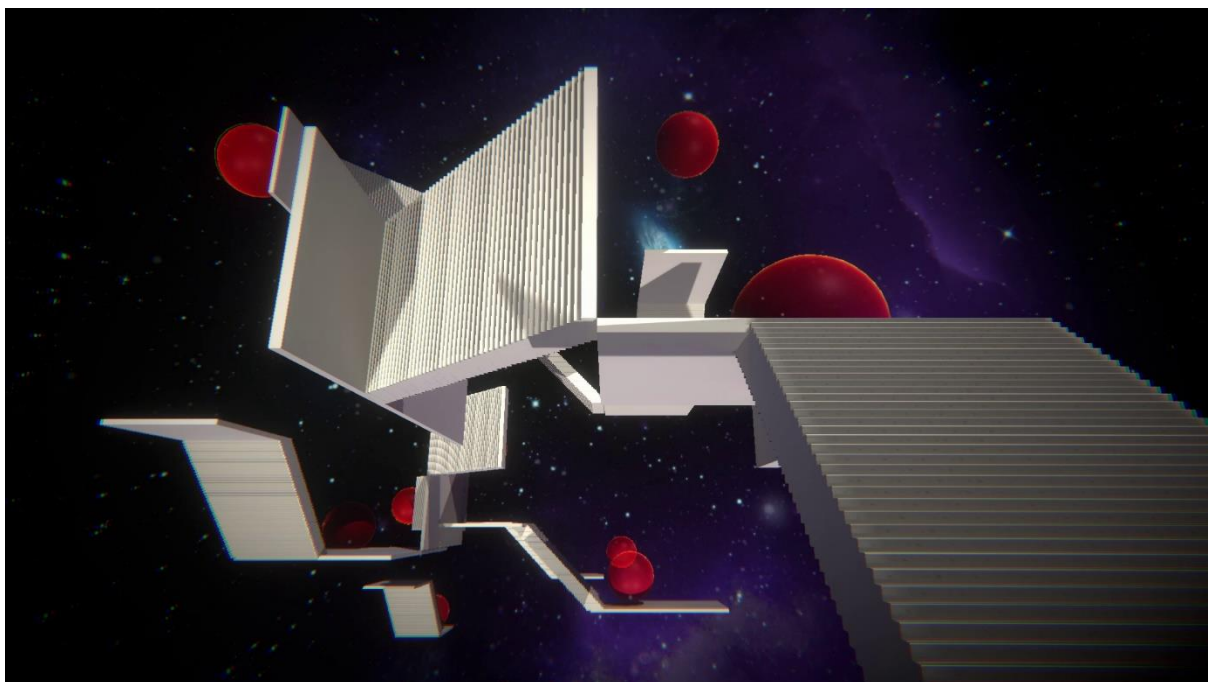


Fig. 21.10 Optical illusions based on the work of MC Escher are used to generate 3D scenes based on altered states in Max Hegarty's project.

Conclusion

Through the course of this chapter we have taken a tour through a series of final year student projects exploring new directions in the use of video game engines such as Unity and Unreal Engine. The projects discussed have explored adaptive music and VR music festival experiences; the representation of parrots and amphibians to communicate animal experiences through game engines; projects which generate retro experiences of nostalgia for players in modern contexts; AI simulations in which NPCs are designed to respond in ways that take into account the needs and emotions of humans; and ASC simulations, in which graphics, sounds, controls and environment designs are radically distorted to represent states of hallucination and intoxication. Each project hints at potential new approaches to use in games, and in some cases the repurposing of game engine experiences to address current sociocultural issues could lead to new audiences for games, and/or new ways to bring contemporary issues and awareness of these topics to gamers.

As discussed, these projects are operating in an area of practical work in developing game mechanics and techniques as research, contributing to work in these areas by suggesting new paths for further exploration. There are also some common themes, which in my role as supervisor somewhat transmit the interests and specialisms of my own research. In various ways these projects all show how game engines can be used to generate experiences that elicit experiences for players, in which sounds, images and interactivity give rise to emotions, memories, engagement, or identification with other people or species. For instance, the adaptive soundtracks and VR music festival projects indicated ways to promote engagement and emotion in music-themed applications. In the projects that simulated the experiences of parrots and the Texas blind salamander, we saw how the interactive audio-visual systems game engines provide can be repurposed to communicate animal senses, potentially leading to greater empathy and concern for other species. In the projects that looked at retro aesthetics in gaming, we were able to observe how the graphics and sounds of video games from the past resonate with the audiences of today, and how these can be incorporated into new projects that give rise to feelings of nostalgia. Meanwhile, through the projects that focused on character AI, we saw how games and VR experiences may use NPCs to tell stories from the past or depict human behaviors in ways that are also emotionally evocative for users. Lastly, the ASC game projects focused on ways in which hallucinations and states of intoxication could be represented in games, using a variety of techniques including visual post processing techniques, real-time audio manipulations, disruption to player control systems, or the illusory design of the spaces and environments that the player navigates.

Taken as a whole, these projects illustrate some novel concepts which broadly point towards the way in which games and VR projects may harness a range of techniques to activate not only the visual and auditory senses of the player/user, but also induce feelings of empathy, emotion, memories, nostalgia; or may illuminate our awareness of other sensory states and perceptual systems. I have noted that these are undergraduate projects, and they have been produced in a relatively short space of time whilst students manage other competing deadlines, and so these prototypes are not always as polished as they could be, and neither are evaluations as rigorous or robust as we would need to extend this work. Nonetheless, a collection of novel prototypes has been presented here, and each includes a proof-of-concept — the spark of an idea, brought into tangible fruition using a game engine. Those sparks have some brilliance to them, and I anticipate that some of these ideas may light the way for new directions in the future use of game engine technologies.

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