



Recreating Gaming Experience Through Spatial Augmented Reality

Vibhuti Sagar^(✉) and Prasad Onkar

Indian Institute of Technology Hyderabad, Hyderabad, Telangana, India
vibhuti.1411@gmail.com, psonkar@des.iith.ac.in

Abstract. Online connections and virtual world have dominated the last few years of our social life. There has been a lack of each other's physical presence. The aim of this paper is to create an experience to connect with people in a physical space. The project is named as Connect. Connect is a series of nostalgic games to be played in a spatially augmented environment. The experience aims to inculcate feel-good emotions and enhance socialization and collaboration. Connect involves the intersection of projection mapping, game design and experiential design. Two nostalgic games, Snake and Pacman, are developed for the experience. Several iterations are made and tested simultaneously. The games are made multiplayer and tested by projecting in different spaces. The final execution is done in Cave Automatic Virtual Environment (CAVE) where people play both the games. The participants felt good after playing and were seen socializing and collaborating with each other. Verbal feedback along with post experience questionnaire confirmed the same, expanding the future scope of the project.

Keywords: Spatial Augmented Reality · Game design · Experiential design · Socialization · Collaboration

1 Introduction

In this online era, we are connecting virtually but losing out on each other's physical presence [1]. The aim of the project is to create an experience for people to connect with each other in a physical space. The project is named as Connect. Connect is a series of nostalgic games to be played in a spatially augmented environment. It involves the intersection of projection mapping, game design and experiential design. The experience should inculcate feel-good emotions and focus on enhancing socialization and collaboration. Figure 1 shows the way to connect these three broad domains to come up with a new experience.

Connect inculcates feel-good emotions by recreating the nostalgic games extensively played during the 90s [2]. These games were simple and widely played by people of all age groups. The aim of enhancing socialization is achieved by making these games as multiplayer [3]. Instead of competitive gaming, the games are made as cooperative where the players come together to achieve a common target. The physical space provides

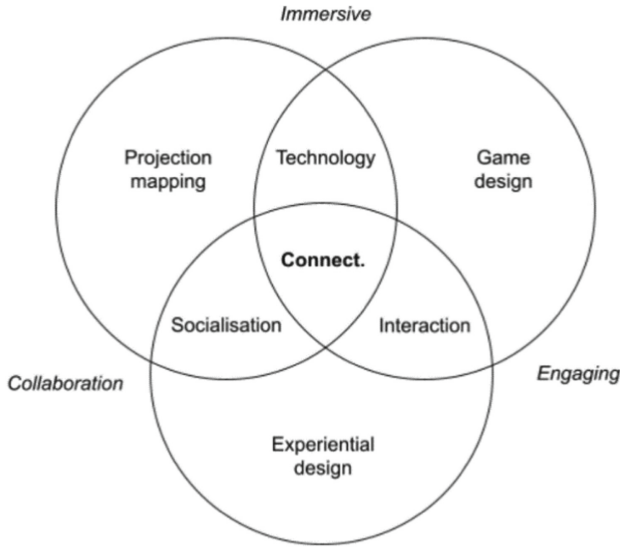


Fig. 1. Intersection of projection mapping, game design and experiential design

an open space for interaction and collaboration which distinguishes it from the usual experience of playing in front of a screen. Projection mapping allows the game to scale up as much as possible and project in different places including 3D objects. These games are projected in the CAVE and people's responses are recorded after the experience.

2 Background

2.1 Spatial Augmented Reality

A special type of Augmented Reality technology, where the combination of virtual and real objects is produced by projecting virtual content onto real objects using projection mapping, is called Spatial Augmented Reality (SAR) [4]. SAR augments virtuality on real objects without using any special displays such as monitors, hand-held devices or head mounted setup. Since the displays are separated from the users, the projection can be scaled up and allow many people to experience together. Projection is the presentation of virtual content on a flat and white screen whereas projection mapping is the projection of virtual content on a non-flat surface like a 3D object [5]. Projection mapping finds its applications in areas like spreading awareness about various causes using the huge canvases, giving life to benign buildings, entertainment industry, marketing, data visualization and interactive projection mapping.

2.2 Design for Social Places

Experiential design. Experiential design is designing experiences for people in physical spaces. The experience design industry consists of artists, designers, engineers, architects, directors etc. [6]. The verticals of experiential design include exhibition design,

environmental graphics, entertainment, placemaking and marketing. Techniques such as video installations, Virtual Reality, Augmented Reality, video mapping, holographic installations, interaction design and immersive environments are used to create experiential design [7]. The technique chosen is based on the project budget, timeline and the installation space. The content strategy includes the content creation, physical installation and live documentation. The concept is explored for understanding the type of physical space appropriate to create the experience.

Socio-technical Design. Socio-technical design is the application of community requirements to people, software and hardware. The community and the technology are one for socio-technical design [8]. Technology that facilitates social interactions should also meet social demands, according to socio-technical design.

Human Computer Interaction. The vision of HCI has moved from just worrying about the productivity of users to being concerned with the wider effects of systems on user experiences, including fun, pleasure, immersion and so on [9]. HCI's initial focus was on individual and general user behavior which expanded to include social and organizational computing for the widest possible spectrum of human experiences and activities.

2.3 Game Design

To make a good game, the position of the player and the goal of the game should be clear. The game scene should have some breathing room, it should not be too zoomed in or zoomed out [10]. The scene should be created to focus on the important elements which can be built by differentiating the values of contrast, saturation, size, movement, indirect focus influencer like geometric lines pointing in the desired direction and so on [11]. The lighting, colour scheme and animation also play a major role in game design. Goal, opposition, choices, and rules are the fundamental elements of a game. Any game needs a balance between the difficulty level and the fairness and similarly, luck and skills.

The application of typical elements of game playing is called gamification [12]. An everyday activity can be transformed into a game. A person is much more apt to remember something if they have moved their body while doing it. People ask for some variation on a game that they've seen or played or seen their kids play. A good game idea is one which is exciting for the developer, possible and reasonable to execute, has a decent audience size and is exciting for the players. A game should easily communicate the information, find a perfect ground between familiar and original, should have appealing fantasy and the capability to evoke emotions [13]. To come up with a game idea, one should start with something familiar. It could be an inspiration from real life, game genre, popular genre, setting, board game, game mechanic and story. Then additions can be done to turn it into something new and original.

3 Related Works

A lot of work has been done in the area of projection mapping. In the paper, Fairy Tale Spectacles [14], the authors explain the various types of projection mapping on buildings and how projection mapping is different than other forms. The difference between

spatial augmented reality and other forms of augmented reality and virtual reality is the solitary experience in the latter, while the former allows for a collective experience. Projection mapping events can be categorized into three categories: architecturally passive: no relation between the architecture and the content, architecturally physically active: relationship exists between the architecture and the content, and architecturally metaphysically active: produces visual effects creating illusions in the architecture.

Some work has been done in creating new video gaming experiences for people, other than playing on usual digital interfaces like computer or mobile. The procedure for developing a novel video game experience is described by the authors in the paper, *Unfolding the 8-bit era* [15] where the nostalgic allure of 8-bit games is preserved, and it is mixed with an immersive, cooperative, multiplayer experience that improves social occasions. The phrase “retro gaming” is a generic one that describes the modern culture of playing or collecting vintage video games from the 1980s and 1990s. These games have a nostalgic quality to them, which has an effect on gaming culture. In this setup, a room is built up with *Super Mario Bros*. Projected on all four sides along with 8 controllers. A new social dynamic was observed where people were talking and laughing with each other and entertained those who were not playing. In another paper, *Sidestep and Sneak Peak: Spatial Actions in Augmented Reality Games* [16], a game concept is put forth that combines dynamic projection mapping and motorized scenery to give players a real engagement with the virtual world of video games. Similar to this, a game concept combining projection mapping on actual items with tactile interactions is introduced in the paper, *ARmy: A Study of Multi-Use Interaction in Spatially Augmented Games* [17] where players maneuver plastic miniatures in a miniature physical setting. Another concern to check for, is the effect of video games on the well-being of a person. Generally, video games are thought to have a negative impact on people. To understand this approach, players of *Plants VS Zombies: Battle for Neighborville* and *Animal Crossing: New Horizons* were polled for the article, *Video gameplay is Positively Connected with Well-being* [18]. Results showed that games can be viewed as a significant source of recreation and socializing, which raises important considerations concerning the possible consequences of play on well-being.

Some work has been done where an intersection of projection mapping and gaming can be seen. *B-Reel London* developed an *EELS* multiplayer game based on 3D projection mapping where the classic snake game was projected on a combination of cubes with the added multiplayer functionality [19]. In another work by Niek van de Vondervoort, *Pacman* game is developed to be projected on a 3D object. The aim of the project was to create an interactive projection mapping experience [20].

Other ways of interaction have been explored where people interact with the systems without using any gaming controls, but rather, human body, with the help of sensors. In the paper, *Personalized Training Through Kinect-based games for Physical Education* [21], a new technique based on Kinect generate learning patches for physical education systems. These are customized for everyone according to their learning status. Other than Kinect, *Leap Motion Controller (LMC)* is also a widely used device for hand tracking. It can also be used for real time projections. In the paper, *Suitability of the Kinect sensor and the Leap Motion Controller* [22], the evaluation of these said devices is done. While

LMC is one of the most accurate and cheap hand tracking sensors, Kinects are two of the most precise, low cost, entire human body motion tracking sensors. In another study, Augmented Reality with MS-Kinect in the Learning of Basic Mathematics: KARMLS Case [23], the motion sensor built into the MS-Kinect camera and Augmented Reality technology, were both used in the creation and development of a computer system named KARMLS. The analysis of the data revealed that the used computer system was more effective with students who had previously performed poorly than it was with students who had previously performed well, and that it had a positive impact on learning when used as an additional tool in the classroom. This shows that moving the body while interacting, helped the children learn in a more effective way. These works on projection mapping, gaming and interaction helped in providing further depth into using projection mapping with gaming.

4 Design and Development

4.1 Snake

Introduction. At its roots, the first version of the Snake was named as Blockade, made by Gremlin in 1976 as an arcade game [24]. Years later, Nokia included Snake in the Nokia 6110, and it quickly became popular, ushering in a new era of mobile gaming. The simple gameplay attracted the attention of a huge audience. The 90s generation grew up playing the game, attaching a certain nostalgia to it. By including projection mapping in different spaces, a new dimension and form of the game with a different immersion level is explored.

Development Stages. Simple graphics were used for the first iteration like square for the snake head and tail segments, circle for food and rectangles for walls. Unity was used as a platform to develop the game. C# was used as the scripting language to code the game. Scripts were added to move the snake using arrow keys, incrementation of snake, food spawning randomly, teleporters to be able to move the snake from one to the other side of the screen and score at the top of the screen. The game would be over if the snake collided with the walls or with itself. The game layout was created according to the box to be projected on. The layout was in the shape of an open net of a cuboid. 5 cameras were added to each surface. Spout sender script was added to send the video feed to the mapping software, TouchDesigner. The spout receiver script is added to get the live video stream on TouchDesigner. The corner points were adjusted according to the faces of the 3D object while viewing the live projection. The game could be played through the keyboard or joystick.

Cooperative (Co-op) games are a type of play or sport in which participants cooperate to accomplish a shared goal. A co-op game aims to place more focus on the social components of play or sport while reducing the emphasis on competitiveness. [25] The co-operative nature of the games is intended to highlight Connect's emphasis on collaboration and sociability. Another snake and more fruits were added. The gameplay included 3 ways to make the game as co-op:

1. Combined score of the two snakes was displayed instead of individual scores.
2. The game would be over even when one snake collided with the other snake, therefore not allowing the players to “cross” each other.
3. The game would be over for both the players even when one player died.

In the next iteration, the sprites were replaced with new graphics, sound effects and animation were added, errors were eradicated, and the latency was removed.

The game was played on the temporary setup where the cuboidal objects were projected with an open net of the layout by a single projector as shown in Fig. 2. The general review of the play was positive with the two players talking and laughing with each other. The audience who was not playing, was looking at the game. Around 25 people tested the prototype. It was mentioned by many of them that it gave a very nostalgic vibe and took them to their younger days when they used to play this in their parents’ mobile phones. Sometimes, the players playing together became competitive with each other. Some people wished that the game was competitive instead of collaborative. Verbal feedback gave a very promising and positive response towards further development and improvement. The next and final iteration is made for the CAVE with the layout adhering to the CAVE dimensions.

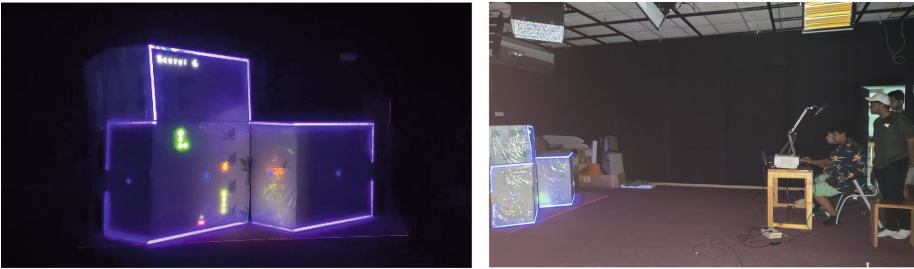


Fig. 2. People playing the snake game on a 3D object

4.2 Pacman

Introduction. In 1980, the original Pac-Man video game was released in Japan before coming to America. Pacman was created as an alternative to the violent games which had become famous at the time [26]. It became a huge attraction when it was released. The arcade version was followed by many different versions. It also has a very nostalgic appeal to it since it was loved by people of all ages across the world. Therefore, Pacman is chosen for recreation to see the effect of this iconic game with a new immersion level.

Development Stages. The layout was created for Pacman on Adobe Illustrator for the CAVE. Different sprites for the Pacman, ghosts, pellets and teleporter were created keeping the originals in mind. The game was coded in Unity with C# as the scripting language. The gameplay was in accordance with the original Pacman with the four

ghosts – Inky, Pinky, Blinky and Clyde. The scripting was done for the Pacman movement, node system for the layout, warping the teleporters, Pacman animation, pellets eating, scoreboard, each ghosts’ movement, ghost modes – frightened, chase and scatter, power pellets, ghost animation and sound effects. The game was played for the initial testing. The gameboard seemed too big for one player.

In the next iteration, another Pacman was added along with a new set of ghosts to follow this Pacman. The gameboard size was reduced keeping the aspect ratio according to the CAVE. Spout script was added to send the video feed of the 3 cameras to the mapping software, TouchDesigner. The screenshot of the playable Pacman with two players is shown in Fig. 3. People play tested the game on two opposite walls of a dark room. This was later projected and tested in CAVE.

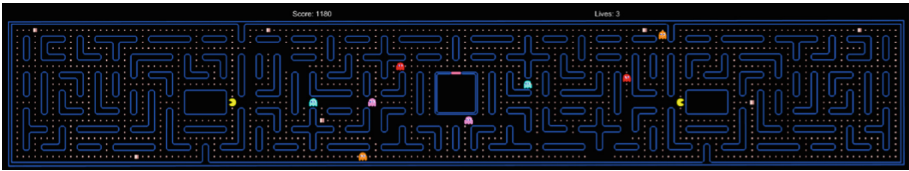


Fig. 3. Screenshot of multiplayer Pacman

4.3 Final Execution

After several rounds of iterations and testing, the scripting of the final games was completed. Snake had 429 lines of code whereas Pacman had 1720 lines of code. CAVE had 4 projectors projecting on 4 screens – left, right, center and bottom. CAVE is used for the final execution as more than one user can stay in the environment at the same time, allowing for interaction and collaboration among the people [27]. Snake and Pacman were executed in the CAVE as shown in Fig. 4.

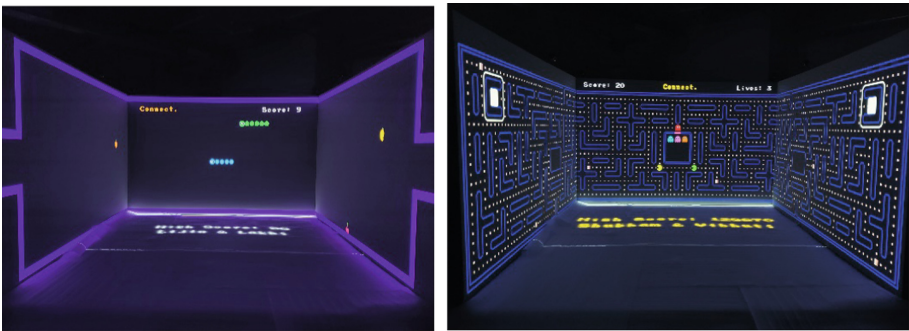


Fig. 4. Execution of Snake and Pacman in CAVE

5 Results

People played both the games in the CAVE. The players were seen talking and laughing with each other while playing. Initially, the players who did not remember Pacman took some time to understand its gameplay. But after a few turns, they became accustomed to it and were seen playing without any hassle. The players were seen moving around in the game. After some time, they started coordinating the use of power pellets in Pacman. They also coordinated which side of the screen to take up in both Snake and Pacman. Sometimes, they divided which fruits to eat in Snake. The players wanted to create a new high score. The people who were not playing, were seen looking at the game of other people. The players mentioned feeling immersed and nostalgic while playing. They were eagerly waiting for their turn to play. The people playing in the CAVE can be seen in Fig. 5.

Around 51 people played the games and filled a post experience questionnaire. The people were faculty, staff, guests and students of Indian Institute of Technology Hyderabad. The average age of the people was 23.58 years. Some statements were given in the questionnaire, based on the experience, with a Likert scale where 1 stood for strongly disagree and 5 stood for strongly agree. The questions were conceived based on the assumptions made while creating the experience. The statements and their average ratings by the participants are given below.

The experience gave me a nostalgic feeling: **4.37**.

I felt immersed in the gaming world while playing: **4.62**.

I felt good after playing the games: **4.72**.

My teammate and I cooperated while playing: **4.47**.

I found myself socializing with my teammate while playing: **4.45**.

While other people were playing, I was looking at their gameplay: **4.37**.

When I was not playing, I was talking to the other people who were not playing either: **3.66**.

Other than this, feedback and suggestions to improve the experience were also mentioned by the people, both verbally and in the post experience survey. This included experimenting and adding more than two players to play. Some surprise elements could be added like the players exchanging controls when they crossed each other. Some sort of competition between the players could also be tried instead of collaboration. The sound and the graphics could be experimented with. People wanted to play more games, including 3D games. Someone mentioned that the corners felt hard to see and the concave screens could be used. Negative feedback was given by very few participants who felt that the music was too loud and felt a headache after playing for some time.

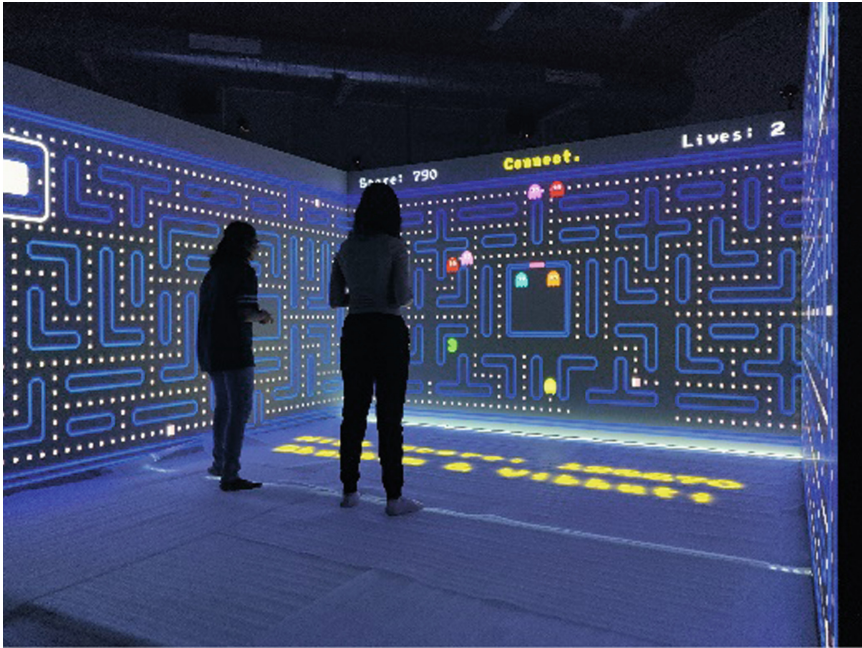


Fig. 5. People playing the games in CAVE (Top: Pacman, bottom: Snake)

6 Discussion

Written and verbal feedback was shared by the participants. Some of the verbal feedback shared are as follows. Participant 1 said, “I think it is much more engaging than the arcade box because you get to move around and play and there are also portals.” The participant made a direct comparison of the created experience with the arcade box and felt that the former was more engaging, because they were able to move around. Participant 2 said, “There is also a blinding thing when you are playing and your partner walks right in front, so you ask them to move. I wasn’t expecting it, but the game is really intense. Once you start getting a score above, let’s say 25000, you don’t blink. The ghosts revive way to fast. So, if you are close to the ghosts’ home, and the ghosts walk back in, there is no incubation period of 1–2 s. It somehow makes the game difficult, and I like it. It could also be played in an entire room including the floor and the roof which would make it really challenging.” The participant mentioned interacting with their teammate and getting intensely involved in the game. The participant was also satisfied with the difficulty level of the game and had some ideas to make it more challenging. Participant 3 said, “It was a very nice experience. The whole setup is very enriching. I enjoyed playing it. It was like bringing back the childhood memories.” Participant 4 said, “I enjoyed playing it. As a child I used to play with my brother and we used to fight all the time, but my teammate played the part really well. We had a lot of fun.” Both the participants mentioned feeling nostalgic and enjoyed the experience.

A rating of less than 4 was received when asked about socializing with people while not playing. This could have been because the people who were experiencing did not come at the same time, rather the crowd was sometimes too dense and other times, too scarce. Due to this, sometimes there were no people to socialize while not playing the games. This anomaly can be cleared by testing the experience in an actual social gathering. Overall, the responses by the participants were very encouraging and positive.

7 Conclusion and Future Scope

The expansion of online connections in the last few years created a void in terms of physical presence. The aim of this project was to create an experience where people could connect with each other in a physical space. The project Connect is a series of nostalgic games to be played in a spatially augmented environment. It is created with an intersection of projection mapping, game design and experiential design. The experience was created to inculcate feel-good emotions and enhance socialization and collaboration. Games such as Snake and Pacman were used which created a nostalgic feeling for the people. The nostalgic games and the enhanced immersion level left the people feeling good after playing. They were seen socializing with their teammate and collaborating wherever required. Out of 5, an average rating of more than 4 was received for the factors such as nostalgia, immersion, feel-good emotions, cooperation and socialization. Overall, the target of feel-good emotions, socialization and collaboration were very well achieved. The post experience questionnaire confirmed the same along with written and verbal feedback. Several suggestions were also given by people to include certain elements in the games which might enhance the experience even further.

Future scope includes testing the experience in an actual physical environment, ideally in a social gathering. The graphics of the currently created games can be modified to give a completely new feel with the same gameplay. Different graphic elements by changing the gameboard, characters and animation can be experimented with. On top of that, instead of recreating a game, an original site-specific game can be created based on the location. It would improve the relationship between the game and the structure as the game will not be entwined that perfectly anywhere else, guarding the originality of the game within that space. The games created in such a way should include certain elements in the gameplay that take complete advantage of the site. The number of players can also be increased. Another exploration can be done by removing the need of gaming consoles to play the game and using different interactive methods like hand gestures, head gestures, eye movement, full body movement and even sound as game controls. These interactions are achieved with the help of various tracking devices. This would involve diving into interactive projection mapping.

Overall, Connect got a very positive response from the people and the concept showed a strong potential. The aim of the project was achieved and addressing the future scope would further enhance the experience.

References

1. Marinucci, M., Pancani, L., Aureli, N., Riva, P.: Online social connections as surrogates of face-to-face interactions: a longitudinal study under Covid-19 isolation. *Comput. Human Behav.* **128**, 107102 (2022)
2. Makai, P.K.: Video games as objects and vehicles of nostalgia. *MDPI* **7**(4), 123 (2018)
3. Barr, M., Stewart, A.C.: Playing video games during the COVID-19 pandemic and effects on players' well-being. *Games Cult.* **17**(1), 122–139 (2021)
4. IGI Global. <https://www.igi-global.com/dictionary/virtual-and-augmented-reality-for-the-visualization-of-summarized-information-in-smart-cities/56556>
5. Bimber, O., Raskar, R.: Merging real and virtual worlds (2005)
6. White, J.: YouTube 8 December 2018. https://www.youtube.com/watch?v=JcHSPpw5XPA&t=2s&ab_channel=fitcevents
7. Chertoff, D.B., Schatz, S.L., McDaniel, R., Bowers, C.A.: Improving presence theory through experiential design. *Presence* **17**(4), 405–413 (2008)
8. Scacchi, W.: *Socio-technical design* (2004)
9. Mathew, A.R., Hajj, A.A., Abri, A.A.: *Human-computer interaction (HCI): an overview* (2011)
10. Bond, M., Beale, R.: What makes a good game? Using reviews to inform design. In: *Computers 23rd Celebrating People and Technology* (2009)
11. Thirslund, A.: YouTube, 24 August 2020. https://www.youtube.com/watch?v=nvbQ9_bzx1k&list=PLYMM76AEEbsQK3ozBddC-kdyZ4Q9v3oHe&index=56&t=1s&ab_channel=Brackeys
12. Marczewski, A.: *Gamification: a simple introduction* (2013)
13. Bowman, N., Hemenover, S.H.: Video games, emotion, and emotional regulation: expanding the scope. *Ann. Int. Commun. Assoc.* **42**(2), 125–143 (2018)
14. Lovell, J., Griffin, H.: Fairy tale tourism: the architectural projection mapping of magically real and unreal festival lightscapes. *J. Policy Res. Tourism Leisure Events* **11**(3), 469–483 (2009)

15. Zünd, F., et al.: Unfolding the 8-Bit Era. In: CVMP'15: Proceedings of the 12th European Conference on Visual Media Production, pp. 1–10 (2015)
16. Tomimatsu, K., Abderson, S.: Sidestep and sneak peek: spatial actions in augmented reality games ARSurface - dynamic spatial augmented reality for tangible interface. *Int. J. Asia Digital Art Des. Assoc.* **20**(4), 77 (2017)
17. Dolce, A., Nasman, J., Cutler, B.: ARmy: a study of multi-user interaction in spatially augmented games. In: IEEE Computer Society Conference on Computer Vision and Pattern Recognition Workshops, pp. 43–50 (2012)
18. Johannes, N., Vuorre, M., Przybylski, A.K.: Video game play is positively correlated with well-being. *R. Soc. Open Sci.* **8**(2), 202049 (2021)
19. B-Reel. Vimeo, B-Reel (2017) <https://vimeo.com/211021181>
20. Vondervoort, N.V.D.: YouTube. 15 December 2019. https://www.youtube.com/watch?v=u5TY33gGCv4&ab_channel=NiekvandeVondervoort
21. Xu, M., et al.: Personalized training through kinect-based games for physical education. *J. Vis. Commun. Image Represent.* **62**, 394–401 (2019)
22. Guzsvinecz, T., Szucs, V., Lanyi, C.S.: Suitability of the kinect sensor and leap motion controller—a literature review. *Sensors* **19**(5), 1072 (2019)
23. Palomino, L.S., Nora, L.-S.P., Fernando, M.G.: Augmented reality and ms-kinect in the learning of basic mathematics: KARMLS case. *Int. Educ. Stud.* **12**, 54 (2019)
24. Krishnankutty, P.: The Print, 18 July 2020. <https://theprint.in/features/nokias-snake-the-mobile-game-that-became-an-entire-generations-obsession/462873/>
25. El-Nasr, M.S., et al.: Understanding and evaluating cooperative games. In: Proceedings of the SIGCHI Conference on Human Factors in Computing Systems (2010)
26. Lowood, H.E.: Pac-Man. *Encyclopedia Britannica* (2004)
27. Tarbi, A.: Laval Blog, 19 August 2020. <https://blog.laval-virtual.com/en/vr-cave-system-an-immersive-technology/#:~:text=The%20word%20CAVE%20is%20an,actually%20stereoscopic%20rear%20projection%20screens>
28. Whitworth, B., Ahmad, A.: Interaction design foundation. <https://www.interaction-design.org/literature/book/the-encyclopedia-of-human-computer-interaction-2nd-ed/socio-technical-system-design>
29. Carroll, J.M.: Interaction design foundation. <https://www.interaction-design.org/literature/book/the-encyclopedia-of-human-computer-interaction-2nd-ed/human-computer-interaction-brief-intro>