



Following the White Rabbit: The Virtual Reality for Games

Paulo Carvalho^(✉)

SIDIA (Samsung R&D Institute Brazil), Manaus, Brazil
p.alexandre@samsung.com

Abstract. In recent years, virtual reality has seen a growth in its investments by the technology industry, despite all the experts' predictions about the duration of the hype around this technology and also with some problems still unresolved, such as motion sickness. One of the segments that receive most of these investments is the Games Area for VR, supported by technology enthusiasts, wishful for technological innovation. This essay analyzes some studies about the VR gaming industry for the understanding of all its actors: from manufacturers to their consumers, including developers, artists and researchers.

Keywords: Games · Virtual reality · Head-mounted display · Smartphones Industry

1 Introduction

Virtual reality (VR) is a computer system that simulates an immersive environment through three-dimensional (3D) objects and scenarios. This technology can have its prolonged immersion effect with the combination of tactile sounds and devices for interaction with the objects and scenarios designed by the system [1]. In recent years, we have witnessed a rush by various technology companies toward popularizing their VR devices, and in recent years have released new versions with updates and new devices. At the same time that several segments such as education, health, simulations and military training have used this technology. However, it is the entertainment industry that concentrates most of the investments related to VR, especially to video games [2]. What is the reason for VR gaming industry to attract more investment than other segments? The present essay aims to analyze some of the key factors that make technology companies make heavy investments in VR for games, as well as provide an overview of the industry.

1.1 Digital Games: The Beginning

The first games were designed to be played by two people with the support of two controls or using digital interfaces such as a light weapon, which would make the gameplay experience more engaging. Designed at first for a single game, the home game consoles were being rapidly improved to support multiple games thanks to the arrival of companies to the game market like Nintendo and SEGA. These companies are among the first to propose that their own consoles have exclusive games, a practice

quite common today. But the great innovation of the time was the launch of Atari in 1977 with its Atari 2600 that replaced the simple sound signal by a real sound based on two mono channels [3].

1.2 Virtual Reality: The Next Step

Virtual reality, like the digital game, adds a set of scientific areas, such as computer graphics, electronics, cognitive science, etc. A virtual reality system aims to immerse its user in an artificial environment where it is possible to feel and interact with objects and scenarios in real time thanks to sensorimotor interfaces [11]. Experience in a virtual environment must be believable enough that the user's senses are stimulated to generate their self-image within that virtual environment. According to Bouvier et al. [3], the sense of presence can be acquired by combining five pillars: immersion, interaction, real time, emotions, and cognitive science.

- Immersion is the introduction of the user into the virtual environment through the senses of vision and hearing that stimulates his perception and understanding in this environment;
- The interaction enables communication between the user and the environment in which he is inserted;
- The real-time system is in its set of tasks and actions to be executed at the expected moment and its perception occur simultaneously to its execution;
- The emotions originated from the virtual experience stimulate the user to make the experience believable with the aid of the interaction devices, which draws his attention from the real world;
- The last pillar is cognitive science that relates, among other things, human behavior with the capacity for interaction and understanding of the environment in which it is inserted, which contributes to the improvement of immersion and interaction in virtual systems [3].

The definition of the term Virtual Reality was created after the second world war, through the simulators of flight of the United States Air Force. In the 1950s, Morton Heiling developed Sensorama, a machine that allowed users to immerse themselves in an experience that consisted of a motorcycle ride in Manhattan. This multi-sensory experience was accompanied by a three-dimensional and colorful film, supported by sounds and smells that simulated the sensation of movement, as well as the wind in the spectator's face [4] (Fig. 1).

In 1966, Ivan Sutherland released *The Sword of Damocles* [5], an installation that merges head tracking and the Head Mounted Display (HMD) making a virtual environment connected to the user's point of view. As early as 1975, Myron Krueger devises an installation called Videoplace, in which the user uses his avatar to interact within a simple virtual environment through a camera. However, the popularization of the concept occurred only from the 1980s with Jaron Lanier, in order to differentiate traditional simulations from those involving multiple users. Lanier founded VPL, one of the first companies to market exclusive equipment to virtual reality, such as data gloves and HMDs [6].



Fig. 1. Sensorama [4]

VR glasses, as well as Head Mounted Displays (HMDs), are commonly accompanied by headphones for enhancing the feeling of immersion in the virtual environment. It is a fact that complete immersion in the virtual world occurs as a result of the involvement of the five senses. However, most VR environments cannot make use of all of them, usually using two senses: vision and hearing [4].

2 The First VR Games

The first releases of games using virtual reality focused on immersing the user's sense of the virtual world. The users performed their interactions in the virtual environment with limitations in their movements - the equipment in which the simulations ran did not allow physical walks or races because it was not portable [7].

The first models of videogames that used the RV were launched in the 1990s, such as *Dactyl Nightmare* [8] and *Grid Busters* [9]. In the same period the Japanese company Nintendo made its investment in virtual reality games through *Virtual Boy*, which proved to be a major failure [10]. Released in July 1995, *Virtual Boy* wasted tremendous potential for success by the time it was released, being referred to as one of Nintendo's biggest failures after being released from the market less than a year after its release and for not meeting expectations of sales, although it was an original system. The company failed to launch a very expensive product, with many technical problems, among them: the lack of head movement tracking, which could rotate the virtual environment relative to the user's head. Another technical factor relates to the absence of the input device that was commonly associated with the VR: the glove. A curious fact is that its display only displays the red color, due to the cost limitations, which made it even more uninteresting for the public, in addition to the many physical discomforts to the players [10].

Currently, the biggest technology companies are present in the market with their virtual reality devices: Facebook Oculus Rift, Google Cardboard, Daydream, HTC Live, Playstation VR and Samsung Gear VR. All have games released or under development for their respective VR systems.

3 The Gaming Industry

The gaming industry is relatively new, as the popularization of the games occurred only between the 1970s and 1980s. The gaming industry is constantly shaped by technology and technological development, while the industry feels pressure to meet its demand not to lose market share to other competitors in the industry [17].

The gaming industry is at the top of the entertainment industry, and continues to grow rapidly. Computer science techniques are primarily responsible for the basis of game industry, and new challenges for computer scientists are represented by new developments in video games. Across the globe, there are massive investments in study programs to expand the workforce in game industry, as the number of computer science academics committed to solving problems and developing algorithms for video games. This set of issues often requires mastery and knowledge of various lines of research, such as psychology and arts, leading to a relevant interdisciplinary field of research, which characterizes the creative games industry [15].

Higgs and Cunningham [18] characterizes the creative industries as those that assure individual creativity, skill and talent as agents for enhancing wealth and job creation by exploiting these intellectual properties. The creative industries have subdivisions spanning ancient arts and literature to contemporary industries based on technological developments such as graphic design, software development and video games [17].

The attributes of the creative industries presented by the gaming industry are essential to understand how they differ from industries in other sectors [17]. Caves [19] defines well the creative industry resources that make up these attributes:

3.1 Uncertainty of Demand

There is considerable uncertainty about demand in the creative industries because reactions to a finished product are unpredictable and subject to certain variables such as individual taste, joint consumption, and others. Therefore, uncertainty of demand may hinder budget projections [19].

3.2 The Respect of the Actors of the Industry for the Originality, Technical Prowess, Harmony

Jobseekers in the creative industries are subject to several sources of motivation to carry out their functions more than, for example, in the manufacturing industries, whose employees have external motivation, generally linked to financial stability [19]. Creative industry workers are usually intrinsically motivated as they see their line of work as an artistic ensemble where originality, technical prowess and harmony are the ultimate results of that association. Due to the nature of creative work, its employees

demonstrate characteristics that are more similar to entrepreneurs than to employees in other industries, a factor that draws attention to companies. These employees have a greater tolerance for risk and uncertainty in relation to a creative company in the industry [19]. It is also emphasized that its employees have intrinsic motivation rather than external motivation to carry out their functions, which makes them oblivious to the traditional control systems adopted by other industries where the motivation usually comes from the financial rewards and financial stability offered by your company [19].

3.3 Diversified Inputs

Because it is too broad, production in the creative industries may require a variety of skills. These skills may include design, writing code, conceptual design, marketing, and finance. This effectiveness in attracting talented employees enough to accomplish their tasks opens up possibilities for new challenges [19].

3.4 Products Discerned by Quality and Uniqueness

The products of the creative industries have their market value tied to their technical quality, which characterizes the industry with a solid foundation in knowledge, making it unique in comparison to other industries. Since uniqueness is so valued, traditional controls from other industries will not have the same effectiveness for standardization in product manufacturing or work philosophy, since different work styles will lead to unique results [19].

3.5 Vertically Differentiated Skills

Abundance of talent can be estimated to a certain extent, since a subtle variation in talent can be a factor of great relevance in success [19].

3.6 Time Is of the Essence

The development and creation of products and services by the creative industries are appropriate processes at the moment of their idealization and, once it is initiated, it is fundamental that all its stages are concluded by seeking their relevance within the market at the moment of their launch [19]. And this is a guiding principle for video games: a new game based on an emerging trend will only be interesting at its launch if its features are contemporaneous with those trends. Monitoring the current scenario and the speed of understanding the reaction to trends and changes are fundamental for gaming companies, which creates an interesting challenge in trying to reconcile the search for success and budget balance together with the previously defined deadline [19].

3.7 Aspects of Durability that Require Copyright Protection

Because they are products originating from the creative industries, with unique characteristics, there is a certain facility in duplicating them and copying them, thus, it is necessary that copyright protections be made [19].

The gaming industry has many characteristics, a singular one where a small number of companies make huge profits compared to other companies in the industry, although most are really interested in creating a great demand for their products [17]. One thing that reinforces this standard of *modus operandi* is the fact that only 5% of the companies with more talents among their employees amplifies in the differences of gains, especially when approaching the reference company of the area [17].

In relation to customers, they tend to wait, and in some situations to request, continuous improvements in the products/services they acquire [17]. A technology client usually takes into account an upgrade or improvement in a replacement, even if this set of services has a high cost. The gaming industry has a similar attitude, with its consumers awaiting continuous improvement [17], as interaction and market share in technology are the main sources of information about the next set of product/service requirements [17].

Gaming companies keep up with market trends, so investment decisions are made based on existing companies' gains and technology requirements in the industry [20].

In the gaming industry, startups seek to ensure stable cash flow into the future, while larger companies deal with the uncertainties the industry brings while seeking to maximize shareholder profits [20]. And as industry relies on new investments due to the short life cycle of the games, the capital reserve plays an important role in growth opportunities. Technology has enabled the emergence of new investment opportunities due to the growth of the mobile game industry, and thus other interactive entertainment alternatives such as virtual reality [20].

4 The Psychological Strategies of VR in Users

Most VR games and environments show the strategies of intrinsic motivation, emphasizing the internal motivation of its users to perform a task, which comes from their own participation in the virtual environment [21, 22]. A research conducted with a focus on intrinsic motivation turned out to be successful from the time students engaged in tasks that required creativity or presented themselves with a certain degree of complexity [23]. However, we cannot say that extrinsic motivation has a negligible role in the game, since intrinsic and extrinsic goals are often mixed. A VR environment can present a very impacting experience, which will cause in its user a pleasurable sensation, as well as disturbing or frightening sensations [24]. The immersion in the virtual environment is a state of consciousness of the physical self that simultaneously diminishes the sensation of physical presence of the world around, intensifying the experience [25]. Being immersed in a virtual environment demands a very specific series of resources internal and external to the environment itself [14].

The public's fervent adoption of new technologies has made it possible to evolve from a resounding need for informal education institutions to the projection of increasingly elaborate exposures that integrate immersive VR, game-based technologies, augmented reality, visualizations, and other emerging media. Advances in simulations for pilot and astronaut training; ubiquitous robots and nanotechnology; satellite image; and the emerging and sophisticated visual data were responsible for creating new opportunities to engage the public in modern science [24]. Data collected from a

study of a virtual reality science exhibition [24] revealed that some learners were alarmed by some samples of unrealistic virtual environments and were positively affected by realistic images. The unrealistic images reduced the immersion sensations while some visual images moved or were alternated to try to induce any sensation of immersion [14].

5 The Current VR Scenario for Games

In the past there were certain barriers to the propagation of technology or the use of HMDs. There was the fact that these technological devices were not widely diffused and were generally very expensive. If on the one hand the devices were not widely diffused, in addition to being very expensive, on the other hand their aspects were peculiar to the point of causing aversion to their potential users, generally due to the mismatch between the movements of the head and the corresponding change in the scene [4].

Currently there is a diversity of options of VR devices offering a good virtual simulation at affordable prices, making possible the use of the systems in other areas, such as education and training. In addition, the technology has improved its systems by providing accurate tracking of movements and low latency, making its usability more user-friendly and thus enhancing the feeling of immersion [4]. All this ends up facilitating the way for the development of games for the VR platform.

In current scene, games find a very wide audience due to the young people's taste for entertainment. This broad public encouraged the creation of portable and more accessible virtual reality systems, developed in laboratories around the world. With this, a global community with property was created to validate a growing ecosystem, using its different concepts and interfaces chosen for a VR application [1].

The market has released many haptic devices because of the immersive interactivity between the user and the virtual environment being increasingly demanded by virtual reality systems. In this way several tools are designed for digital games, adding elements of vibration or feedback [1].

6 The VR Games User's Profile in Brazil

In Brazil, according to a survey conducted in 2014 by BNDES (Banco Nacional do Desenvolvimento Econômico e Social) [26] about digital games, video game is the fourth activity most practiced by young people. According to their data, 35% of children and adolescents aged 9 to 16 years play daily, 45% play at least once a week and 19% at least once a month [16].

In a survey conducted with consumers of digital games at some of the major malls in the city of Manaus and São Paulo, Brazil, tests were done with two games, the Finding Monsters [28] (Fig. 2) and Rock & Rails [29] (Fig. 3), produced by Black River Studio for Samsung Gear VR.

From this approach we can gather data that clarify the preference of these consumers, according to the Tables 1 and 2 below:



Fig. 2. Finding monsters [28]

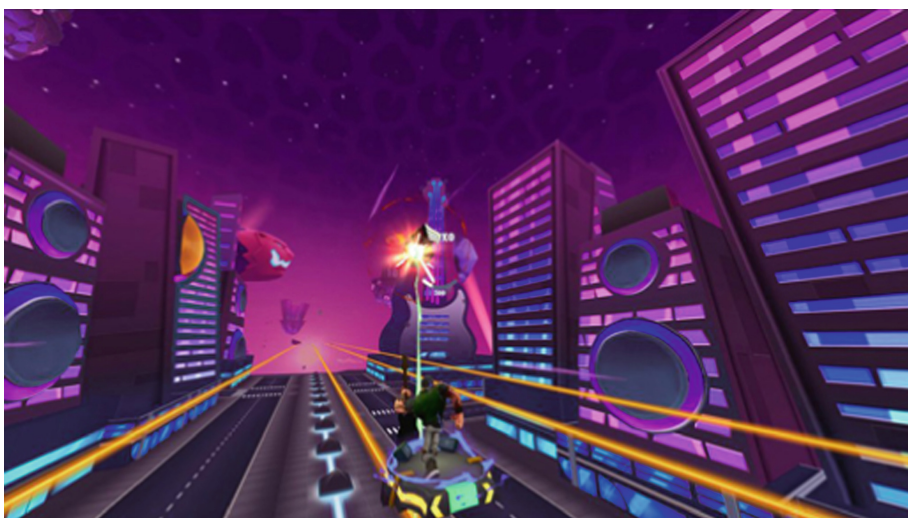


Fig. 3. Rock & Rails [29]

Another research was conducted by Wilson Silva (UX Researcher) and Mamoru Miyagawa (Game Producer) at the VR Gamer game store in São Paulo, Brazil, about the Highlander game for Gear VR, with purpose of validating some elements of the game, such as narrative, mechanics and emotional aspects. Important data were collected on the profile of the consumers of games for the VR [27]:

Table 1. Survey about digital games and VR.

Gender	Age	How often do you play?	Which platform?	Have you ever had contact with VR?	Rate the game Finding Monsters VR with grades (1–5)	Rate the game Rock & Rails VR with grades (1–5)
Male	26 to 34 years	2–6 day	Mobile, PC	Yes	5	Not available
Male	19 to 25 years	Rarely	Mobile	Yes	5	3
Male	>45 years	Rarely	Mobile	Yes	5	5
Male	<16 years	2–6 day	Console	Yes	5	4
Male	26 to 34 years	Rarely	PC	Yes	5	3

Table 2. Survey about VR.

Gender	Age	What content do you expect to find in VR?	Evaluate your VR experience	Would you buy VR?	Would you recommend the Samsung Gear VR?
Male	26 to 34 years	Entertainment, games, sports	5	No	Yes
Male	19 to 25 years	Entertainment, games	4	Yes	Yes
Male	>45 years	Entertainment, education	5	Yes	Yes
Male	<16 years	Entertainment	5	Yes	Yes
Male	26 to 34 years	Entertainment, sports	5	No	Yes

- Total number of participants: 23;
- Average gameplay time: 15 min, with a maximum of 21 min and a minimum of 07 min;
- Target audience: all player profiles, non-gamers, casual, mid-core and hard-core profiles were addressed.

Non-gamers had difficulty with tutorials, while casual and mid-core gamers liked the mechanics but criticized the detail poverty in the story. Hard-core gamers have criticized technical aspects of the game, especially in relation to graphics, character design and movement, as well as the poverty of details in the story as well. When asked, most would like to play the game again in order to better explore the scenario and environment. In relation to the narrative most liked, but they would like to know more about the world and have more details about the mission, the reason why they failed to create any emotional bond with protagonist of the game, precisely because of lack of information about this character [27].

However, for gamers there is a general perception that the Samsung Gear VR is the weakest VR game platform (especially comparing with Rift and Playstation VR), also that mobile game is not as good and well made as other video games. Thus, the survey revealed that the game has more potential of success with casual and average players [27].

7 The VR Obstacles for Video Games

Possibly, in terms of sales, one of the big competitors of commercial video games and VR games are mobile games, due to its ease in being marketed, for its practicality of use. The development of smartphones applications and games becomes practical, as well as their academic study, since it uses small teams of academics and students who are able to work with reduced budgets. Using the specifications of a smartphones as an example, we have a reduced graphics screen with limited hardware, common to mobile devices, which will lead to the production of games with simple graphics with often only 2 or 2.5 dimensions of resolution, which need for large teams of highly skilled artists and 3D modelers. Not to mention the wide variety of inputs that mobile devices offer (touch, images, sound, acceleration, orientation, personal data, etc.) and more output options (images, video, animation), sound, vibration, wireless, bluetooth, infrared) that is usually made available on a desktop or laptop computer. It also adds to the popularity of mobile devices that naturally attracts a large number of casual users, thereby providing a virtually large data source [15].

One of the factors that still hinders the popularization of games for VR is Cybersickness, even with content-producing companies and manufacturers investing in surveys that seek solutions to such problems. Most VR device manufacturers as well as game producers have invested a lot of time and money into research to find alternatives that reduce the discomfort caused by prolonged use of devices. In some cases, circumstances are becoming clearer, for example the Oculus Rift, where the design of some games could have favored the induction of some diseases due to a large volume of rather complex interactions over prolonged periods [12]. In other cases, improving interfaces in flight simulation games at their 360° related locomotion interfaces can make them promising. They are fundamental elements in games, as well as spatial orientation or navigation tasks. Many developers devise alternatives in an attempt to minimize the effects of cybersickness, such as the design of hands-free locomotion interfaces with full rotation and tilt-based translation [13].

8 Conclusion

The research made it possible to have a deeper understanding of the gears of the ga-ming industry focused on VR, essentially because virtual reality is a gathering of multiple scientific domains rather than a single one. These various areas of research are enhanced by the needs of VR applications. Some of these improvements generally move to the mass market since the cost of development is reasonable. One of the main goals in virtual reality applications is to provide means to immerse the user's senses in an artificial virtual environment (VE) through an interactive experience. A key factor

on how this interactive immersive experience is successful refers to the sense of presence. Another factor is the ability to simulate environments that exist in our physical world, makes the virtual reality system for games to be chosen among players, to the point where game producers develop highly realistic graphics, such as first person shooter games (FPS).

Although VR is over 50 years old, there have been many failed attempts in the period, until in recent years, from the last decade there has been an intensification in device-related research, often thanks to the creativity of game producers in creating thinking platforms the maximum immersion provided to the user. And the gaming industry has expanded the immersion barrier, especially with VR. Due to being naturally followed by ardent fans of technology, the gaming industry determines the trends of the times to come, specifying the requirements of each technology feature implemented in the systems so that they can be constantly improved as the capacity of their hardware components increases, whether they aimed at the platform or VR games.

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