

VideoGames at the Library: A Historical Perspective

Gustavo Marfia*, Alessandro Amoroso*, Marco Rocchetti*, Giulio Basile*, Claudio E. Palazzi†

* Dipartimento di Scienze dell'Informazione - Università di Bologna, Italia
Email: {amoroso, marfia, roccetti}@cs.unibo.it

† Dipartimento di Matematica Pura e Applicata - Università degli Studi di Padova, Italia
Email: cpalazzi@math.unipd.it

Abstract—We present an overview of the video games available at the Film Library of Bologna. This institution, in collaboration with the University of Bologna, has a whole collateral branch dedicated to the video games, as they can be considered a recreational activity somehow related to movies. This collection of video games conceptually starts from the ones that are strictly connected to movies, and then expands to a wider class of video games. A video game could be related with a movie either as its direct inspiration, its prequel or collateral plot, or also be created as a direct consequence of that movie. The expansion of the collection available in the Library includes a historical set of video games.

In this paper we discuss the historical perspective of the relationship between technology and video games, providing a complete historical view of the video games by means of the titles and the consoles available in the Library. Several dedicated consoles are still in working conditions and could be used by the visitors of the Library.

I. INTRODUCTION

The collection of the Play Room of the Film Library of Bologna contains about 2000 video games, whose releases range from 1979, till the present date. The library collects both video games and consoles, a visitor can therefore play a game interacting with the original hardware. Not all of the collected console are accessible at any time: some of them, usually the oldest ones, are available only upon reservation. In any case the access to any of these resources is free.

Figure 1 shows the timeline of available software with respect to each platform in the Library collection. Each solid rectangle after the name of a platform shows the whole interval of available software for that platform. The dotted horizontal lines separate the platforms by their generations, labelled at the left of the figure.

All the platforms are available to the visitors of the Library, but as anticipated before, some of them are available under restrictions. The consoles released before 1994 are available upon advanced reservation solely, whereas the newer ones can be freely accessed. Same restrictions also apply to the PCs. Figure 2 shows the number of titles available at the Library for each platform.

Figure 3 shows the number of titles available with respect to their release date. Not surprisingly, a higher number of titles are available for more recent dates.

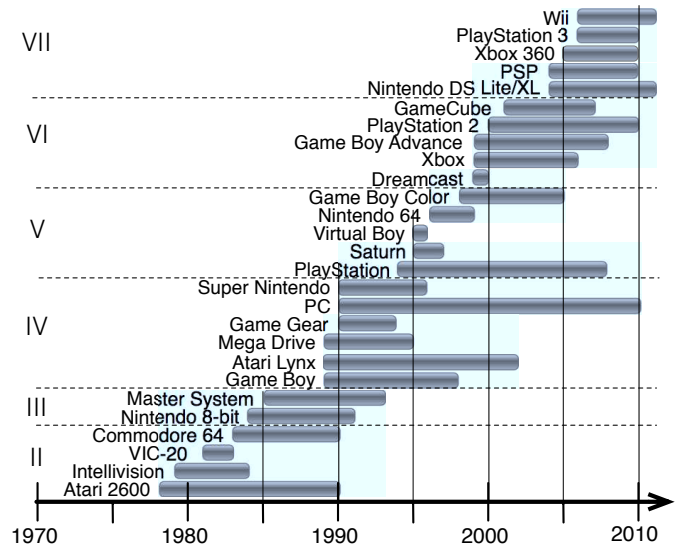


Fig. 1. Temporal distribution of games available at the Library with respect to the hardware platforms

Unfortunately, in both the Figure 3 and 2 the label “PC”, that comes from the Library directory, is far too generic. It ranges from Mac to Windows computers, and does not differentiate the hardware neither with respect to its release date nor its configuration.

II. GENERATIONS

We can distinguish several generations of video games, that are characterized by both hardware and software. We follow the classification reported in [1] as a guideline for our analysis.

It is worthwhile to notice that the targeted video device for the home consoles was the contemporary TV, therefore their video capabilities were usually calibrated with respect to the common TV capabilities. The sound output gained importance during the years, as the computational power increased enough to produce more accurate sounds.

The initial input devices for the home consoles were paddles with knobs and buttons. After this initial phase the joystick became available and was used for several years, both with home computers and consoles. More recent generations

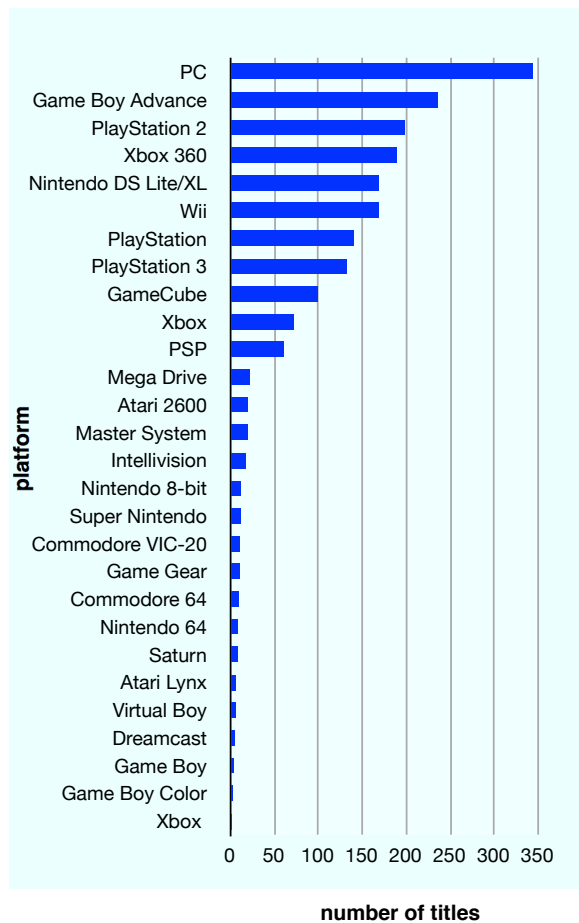


Fig. 2. The number of different titles per platform

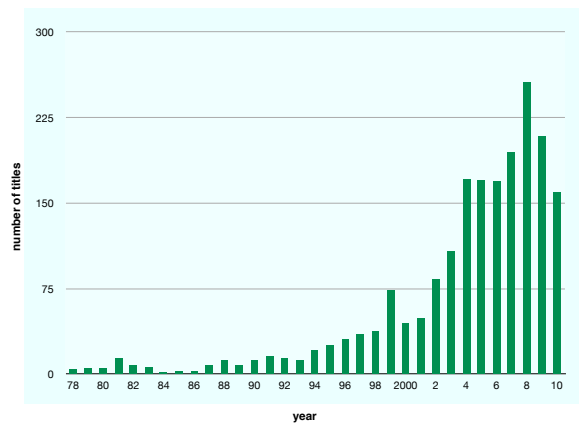


Fig. 3. The number of different titles per release date

of consoles became equipped with sophisticated remotes, that evolved to be wireless, and in some cases completely disappeared. The latest consoles are now capable of sensing the movement of the user's body in the three dimensional space.

The handheld platforms evolved very quickly in this late years, and it seems that they are merging with the smart-phones.

The network connectivity of consoles was introduced only few years ago, but it is quickly gaining popularity, providing support for massive multiplayer online games.

The description of the consoles starts with quite precise specs on CPU clock, such as in the first generations. While this measure become not representative of the power expressed by the consoles, the description shows the performance of them.

III. VIDEOGAMES: EARLY SEVENTIES, EARLY EIGHTIES

A. First Generation

It represents the dawn of video games for dedicated consoles. This generations spans from 1972 to 1977. It begins with the release of the *Magnavox Odyssey* [2]. In 1977 several manufacturers abandoned the market, and solely Atari and Magnavox continued to produce consoles.

We do not further discuss this generation because it is very old and because no devices nor video games of this generation are collected in the Library.

B. Second Generation

Three consoles characterized the second generation, also called the *8-bit generation*, that spans from 1977 through 1983. In 1979, the release of the *Atari 2600* [3], initially called Video Computer System (VCS), marked the beginning of this generation. In 1980 Mattel released the *Intellivision* [4], followed by the *Coleco Vision* in 1982. Both the Atari 2600 and the Mattel Intellivision are available at the Library.

During this generation, video games were stored in ROMs, embedded into plastic cartridges. These cartridges could be inserted in a slot of the console, which, equipped by a general purpose microprocessor, ran the software stored in the mounted cartridge. Such architecture represented a considerable advantage: users were no more limited to play with pre-installed video games, being now able to buy and collect the cartridges (i.e., the games) they wanted.

Both the Atari 2600 and the Intellivision were equipped with a CPU cycling at about $1MHz$. The Atari's RAM was $128bytes$, while the cartridges could include memory expansion. The Intellivision had about $1500bytes$ of RAM. Their video output was on a regular TV at about 160×200 pixels. The Atari was able to display slightly more than 100 colors, while the Intellivision was limited at a 16 color palette. *Sprites* were the common technique to display moving figures on the screen.

The Atari 2600 was originally released with 9 titles, two of them (*Combat* and *Street Racer*) are available at the Library. Later, new titles were released and, among these, the best selling titles for this console were *Pac-Man*, that sold more than *7million* copies, and *Pitfall!*, that sold about *4million* copies. Both of them are available at the Library. The best selling titles for Intellivision include: *Las Vegas Poker & Blackjack* (*2million* sold), *Major League Baseball*, *NFL Football*, and *Space Battle*; the last three sold more than a million copies [5]. All of them are available at the Library.

Pac-man for the Atari 2600 was a port of the very famous namesake *arcade* game. Several titles of that age were ported

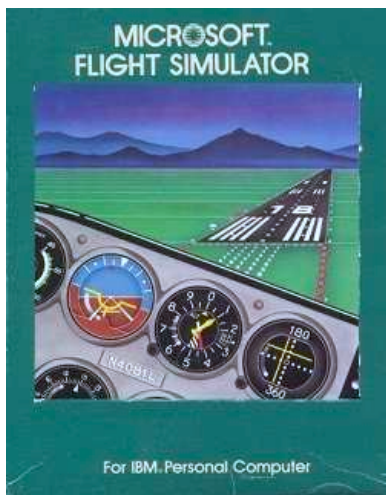


Fig. 4. The cover of Flight Simulator

from existing arcade games. Interestingly, some titles, such as *Baseball*, were also ported between the two consoles. The Library has the versions of *Baseball* for both the consoles, hence enabling a valuable comparison.

During the same years, Commodore released two of the first best selling personal computers: the *VIC-20* (1980) [7] and the *Commodore 64* (1982) [8]. The *VIC-20* was the first home computer that sold more than 1million units. The successor of the *VIC-20* was the *Commodore 64*, that sold something in between 12 and 17million units [6]. They were both equipped with an 8-bit CPU running at about 1MHz, and the RAM was 5KB for the *VIC-20* and 64MB for the *Commodore 64*. The video output of the *VIC-20* was 176×184 with 8 colors, while the *Commodore 64* had 320×200 with 16 colors and 112 sprites. Both were considered gaming computers due to the great variety of available video games available for them. The Library of Bologna collects 11 titles for the *VIC-20* and 10 for the *Commodore 64*.

One of the most famous video games of this generation is *Microsoft Flight simulator*, first released in 1982 and shown in Figure 4. As suggested by its name, it was a flight simulation, for Windows. Due to its accuracy and completeness, some of its direct successors have been used for decades as training tools in several flight school. Microsoft bought the original version from SubLOGIC, that developed the first release in 1976. It started with the simulation of few airports and airplanes, and then grew by adding new airports and landscapes. Since its platform was a computer, its original distribution media was the floppy disk.

IV. THE MAGNIFICENT EIGHTIES

A. Third Generation

The third generation spans from 1983 to 1995. It begun with the release of the *Nintendo Entertainment System* (NES). It is characterized by the scrolling graphics, that surpassed the previous technology of single screen, while it still mounted an 8-bit processor, running at about 1.7MHz. One of the most

successful rivals of the NES console was the *Sega Master System*, released in 1985. Nintendo released in 1989 the first model of a long series of *Game Boy*, that was the first widely popular handheld gaming console.

The most famous and best selling game of that period was undoubtedly *Super Mario Bros* for the NES, that sold 43million copies, while its sequels, *Super Mario Bros 2* and *Super Mario Bros 3* sold 18 and 10million copies, respectively [9].

The basic idea of scrolling graphics, introduced by the NES, is that the screen shows only a portion of a bigger virtual screen; in other words, the screen is like a window that could be “moved” on the virtual screen to show a new portion of it. The software was still released on cartridges, while floppy disks begun to be popular as distribution medium.

The main memory of the NES was 2KB, while it was also equipped with 2KB of video memory. The video output was 256×240 pixels with 25 simultaneous colors and 64 sprites. The Master System had a 8-bit processor, a *Zylog Z80* clone, running at about 3.5MHz, the main memory was 8KB, while the video memory was 16KB. The video resolution was at most 256×240 pixels with 128 colors (16 different colors, each one with 8 degrees of intensity) and 64 sprites at most. The *Game Boy* had a custom 8-bit CPU, running at about 4.2MHz, 8KB of main memory and the same amount of video memory. The display was 2.6 inches, showing 166×144 pixels with four levels of gray.

The Library collects all the three *Super Mario Bros*, and some remarkable titles for the Master System, such as the *Alex Kidd in Miracle World* and *Wonder Boy III: The Dragon's Trap*. Note that, while the Figure 2 and 3 reports the names used in the classification adopted by the Library, the NES and the *Sega Master System* are labelled as “Nintendo 8-bit” and “Master System”, respectively. Moreover, the library collects also few titles for the original *Game Boy*, such as *Tetris*, that sold more than 36million copies.

Super Mario Bros, and its successors, is the best selling video game to date. It was first released in 1985 (see Figure 5) and originally developed for the NES and the arcade consoles. Successively, Nintendo released new and improved versions of *Super Mario Bros* for each one of the subsequent consoles it produced. This is a *platform game*, where the character, called Mario, jumps between platforms, which define the levels of the game.

B. Fourth Generation

The fourth generation is characterized by the advent of 16-bit processors. It started in 1987 with the release of the *PC Engine* from the *Nippon Electric Company*, NEC. Nevertheless, the most popular consoles of that period were the *Sega Mega Drive*, released in 1988, and the *Super Nintendo Entertainment System*, also called *Super NES*, released in 1990.

Even the handheld consoles gained new hardware in this period: in particular, with the release of the *Atari Lynx* and the *Sega Game Gear*. The *Lynx* introduced several new features

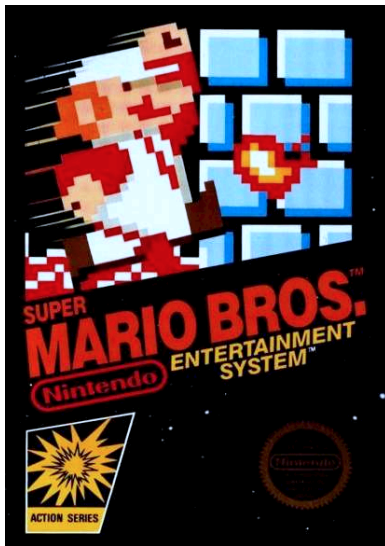


Fig. 5. The cover of Super Mario Bros

to the handheld consoles, such as the backlit display, a left-handed switch, and the capacity to network with 17 other units by using cable connections.

The best selling titles for the Mega Drive were: *Sonic the Hedgehog 2* (6million copies sold) and *Sonic the Hedgehog* (more than 4million copies sold). In the case of the Super NES, the best selling title was *Super Mario World*, that sold more than 20million copies. As a measure of its popularity, ten of the Super NES titles sold more than the best selling title for the Mega Drive.

The Mega Drive was equipped with a *Motorola 68000* running at about $7.7MHz$, and had 64 KB main memory, the same amount of video RAM and 8 KB of audio RAM, that first appeared in this generation of consoles. The video output could be 320×448 at most, showing 64 sprites and 512 colors. The Super NES had a 16-bit processor running at about $3.6MHz$. The main memory was 128KB, and it was the same amount for the video memory. The video output was 512×448 at most, 128 sprites and 32768 colors.

The Lynx had an 8-bit CPU at $4MHz$, with a 16-bit address space, and 64 KB of RAM. It also had a math co-processor, and a hardware graphics processor running at 16 MHz. The 3.5 inch screen was equipped of 160×102 pixels and 4096 colors. The Game Gear was equipped with the *Zilog Z80* at about $3.6MHz$. The RAM was of only 8 KB, the video RAM of 16 MB, and the screen size was 3.2 inches. The screen resolution was the same of the Game Boy, 166×144 , with 32 colors onscreen with respect to 4096 available and a maximum of 64 sprites.

The Library collects several of the best selling titles for both the Mega Drive and the Super NES. Moreover, the Library has several best selling titles for the two handheld Lynx and Game Gear.



Fig. 6. The Virtual Boy

V. VIDEOGAMES: FROM THE NINETIES TO NOW

A. Fifth Generation

The 32-bit and 64-bit generation started in 1993 and lived through 2006. The most important consoles of this period were the *PlayStation*, the *Nintendo 64*, and the *Saturn*. The PlayStation was first released in 1994 and sold more than 102 million units [10]. The Nintendo 64 was released in 1996 and sold about 33 million units [11]. The Saturn, released in 1994, sold slightly less than 10 million units [12].

Among the handheld consoles the *Game Boy Color* was one of the most relevant.

This generation was characterized also by the experimentation of new kinds of consoles. However, some experiments were unsuccessful, such as the *Virtual Boy*. That platform was supposed to deliver real 3D graphics, but it did it with only two colors: red and black; the result was a very tiring experience for a player's eyes. Moreover, a very limited amount of titles was available for that platform, only 25, mostly deriving from a porting of previous games. Nevertheless, the Library has one of those consoles, and 6 of its titles. Figure 6 shows the Virtual Boy.

Fortunately, in a such rich generation of both hardware and software, all the above mentioned platforms are available at the Library.

The consoles of this period tended to emphasize the number of bits of the CPU word size, that was marketed as a kind of power index for many years. The common personal computer of this period had enough memory and computational power to emulate the previous generations of 8 and 16-bit systems. This represented a completely new direction in the video game industry. The fifth generation introduced fully 3D games, i.e. games that were staged in real 3D environments. As an example of this evolution, consider both *Final Fantasy VII*, *Myst*, and *Tomb Rider*.

The cartridges started to disappear, and were gradually replaced by CD-ROM. The Nintendo was the only major platform to continue to use the cartridges.

The Saturn had a dual processor CPU, 32-bit RISC, running at about $30MHz$. The CPU had an operating performance of 30 MIPS, more than 2MB of main memory, 512KB



Fig. 7. The cover of Final Fantasy VII

of video memory, 512KB of sound memory. Moreover, it was equipped with 512KB of cache memory for the CD-ROM. The audio was managed by a custom sound processor. The video output was 521×512 pixel with 64 colors. The processor of the PlayStation was also a 32-bit RISC, running at about 34MHz. The internal memory was 2Mb, and the video output was 640×480 . The graphical processor unit had a performance of 66 MIPS. The sound processor, with 515KB of memory, ran at 44.1MHz. The Nintendo 64 had the most powerful processor, a 64-bit CPU running at about 100MHz. Its bottleneck was the 32-bit bus. A so called “Reality co-processor” was dedicated to the video effects. The video output was 512×512 .

The best selling title for the PlayStation was *Gran Turismo*, exclusively for the PlayStation, which has sold more than 10million copies of both versions one and two. Final Fantasy VII and VIII sold about 10million copies each.

A cornerstone for the video games of the fifth generation was *Final Fantasy VII*, released in 1997 (see Figure 7). This game had a surprising exceptional graphics with respect to its competitors, the plot was very enthralling, and the characters were very well developed. This is a “role game” that generated a great number of sequels. Final Fantasy has been released for the PlayStation, and the Windows PC. The plot has both explorative phases and fights, and the adoption of full motion videos really enhanced the video experience. It was originally distributed on CD-ROM.

Another relevant title, that influenced a long series of successive video games is *Myst*, released in 1993, see Figure 8. It was available on the most relevant consoles of its period, and even Windows and Mac computers; it was originally distributed on CD-ROM. *Myst* was a revolutionary graphical adventure where first a player was immersed in a realistic world to explore. *Myst* had a very sophisticated graphics that captured the attention of its users.

B. Sixth Generation

This was the generation available at the beginning of the 21st century. The main platforms of this period were: the Sony *PlayStation 2* released in 2000, the Sega *Dreamcast* released in 1998, the Nintendo *GameCube* released in 2001,

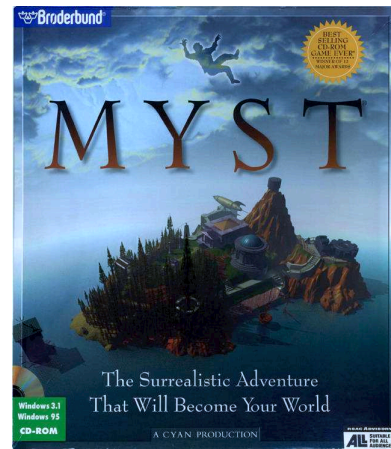


Fig. 8. The cover of Myst

and Microsoft *Xbox* released in 2001. On the handheld side, the most relevant were the *Game Boy Advance* released in 2001. All of them are available at the Library. The PlayStation 2 is the only one of the bunch that is still in on sale. With its record of 140million of sold units, the PlayStation 2 is the best selling console to date.

This was the first generation to introduce online games. During the sixth generation consoles gained PC-like architectures, and introduced the DVD as game media. The Nokia *N-Gage* also appeared, first device that integrates a phone and a handheld gaming platform.

The 64-bit CPU characterized this generation. The PlayStation 2 had a processor running at about 300MHz and delivered more than 6GFlops. The main memory was of 66MB, while its graphics processor was able to manage 32million of polygons per second, with a video output of 1280×1024 pixels; it also gained a 32bit Z-buffer. The sound processor was able to output Dolby Digital 5.1 Surround sound, (DTS). The Xbox had a custom version of the *Pentium III* CPU, running at 733MHz, and a main memory of 64MB. The GPU was able to deliver 115million vertices/second. The innovative aspects of the Xbox were an internal hard disk to store both the operating system and the games, and an high speed Internet connection by means of an Ethernet connector (hence, opening the way to massive multiplayer online games [13], [14]). The Game Cube had a *PowerPC* CPU at about 500MHz. It was the first console from Nintendo that used used optical drive instead of the cartridge, however, it adopted a non standard support. The Dreamcast was the first one of its generation to be discontinued. It was equipped also by a 56Kb/sec modem.

One of the initial, and very famous, “first-person shooters” is *Doom*, released in 1993, see Figure 9. *Doom* was released for a great number of platforms, and relied on a graphical engine, that imposed some minimal hardware requirements. The game was very violent, and had a controversial reception.

C. Seventh Generation

This is the current generation of video games. The Blu-ray Disk replaced the previous DVD as a software support,

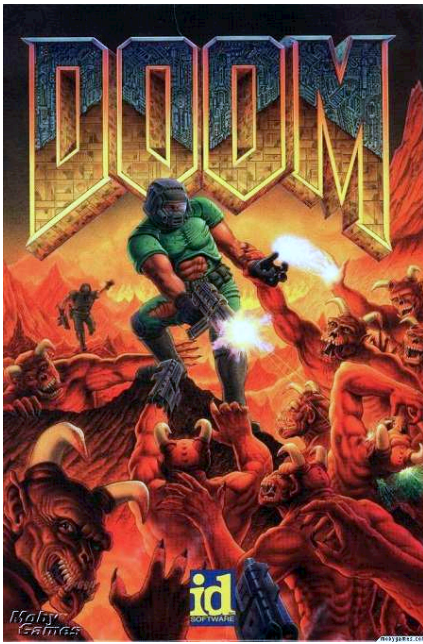


Fig. 9. The cover of Doom

and the video output was the HD-DVD. The disruptive new technology that was introduced at this point was the “motion input”, firstly presented by the Nintendo *Wii*. The main idea is that the user generates inputs by means of body movements, that are wirelessly detected by the console [15].

The main consoles of this generation are the above mentioned Nintendo *Wii*, released in 2006, that sold about 85million units to date, the Sony *PlayStation 3* released in 2006, that sold about 48million units, and the Microsoft *XBox 360* released in 2005, that sold about 50million units. The main handhelds are the Sony *PSP* and the Nintendo *DS Lite/XL*, both released in 2004. All of them are still in production, and available at the Library.

The *Wii* was the first to introduce a new kind of input device: a wireless remote whose movement in the space are sensed by the console, by means of infrared signals. The user grasps the remote to play games. The video output of the *Wii* is not very sophisticated, especially with respect to its competitors, but its focal point is the innovative input technology. The *PlayStation 3* has a wireless remote that is tracked by a camera on the console. The *XBox 360* introduced a new technology to track the user body and its movements in the 3D space by means of a set of sensors called *Kinect*. The very innovative part is that the user does not need to carry any device.

Some of the most popular titles for the current generation of consoles, includes: *Halo* (*XBox 360*), released in several versions, an immersive reality first-person shooter, *Grand Theft Auto IV* (*XBox 360*, *PlayStation 3*, *Windows*), an immersive action-adventure, *Super Mario Galaxy* (*Wii*), *BioShock* (*Mac OS X*, *Microsoft Windows*, *PlayStation 3*, *Xbox 360*), a first-person shooter, and *Wii Sports* (*Wii*), the first generation ever

of motion input games. All of them are available in the Library.

VI. THE FUTURE

Summarizing, two distinct trends can be found every time a new console or title are created.

The first, which is more conservative and more continuously exploited in time, consists in the tendency to increase the processing power and the graphical rendering of a game. The second, instead, amounts to searching for new innovative ways and ideas that may improve the interaction between a player and a game.

Following the second trend with the introduction of the *Wii*, in the recent past, has led Nintendo to double the sales of its direct competitors.

VII. CONCLUSION

We discussed the branch that collects video games at the Film Library of Bologna, which, very interestingly, proposes to its users a very consistent view of the main steps of the video game history.

ACKNOWLEDGMENT

The authors would like to thank the Italian FIRB DAM-ASCO project for funding this work.

REFERENCES

- [1] http://en.wikipedia.org/wiki/Video_game_console
- [2] <http://www.pong-story.com/odyssey.htm>
- [3] Perry, T.; Wallich, P. "Design case history: the Atari Video Computer System", *IEEE Spectrum*, 20(3)March 1983, pp. 45-51.
- [4] <http://www.intellivisionlives.com/>
- [5] http://en.wikipedia.org/wiki/List_of_best-selling_video_games#Atari_2600
- [6] <http://arstechnica.com/old/content/2005/12/total-share.ars>
- [7] Finkel, A.; Harris, N.; Higginbottom, P.; Tomczyk, M. (1982). *VIC 20 Programmer's reference guide*. Commodore Business Machines, Inc. and Howard W. Sams & Co, Inc.. ISBN 0-672-21948-4.
- [8] Commodore Business Machines, Inc., Computer Systems Division (1982). *Commodore 64 Programmer's Reference Guide*. Commodore Business Machines, Inc. ISBN 0-672-22056-3.
- [9] Craig Glenday, ed (2008-03-11). "Hardware: Best-Sellers by Platform". *Guinness World Records Gamer's Edition 2008*. Guinness World Records. Guinness. pp. 50. ISBN 978-1-904994-21-3.
- [10] *PlayStation Cumulative Production Shipments of Hardware*. Sony Computer Entertainment Inc. http://www.scei.co.jp/corporate/data/bizdataps_e.html.
- [11] *05 Nintendo Annual Report*. Ltd. Nintendo Co., Ltd.. 2005-05-26. p. 33. Retrieved Feb. 2011. <http://www.nintendo.com/corp/report/NintendoAnnualReport2005.pdf#page=33>.
- [12] lake Snow (2007-05-04). "The 10 Worst-Selling Consoles of All Time". *GamePro.com*. <http://www.gamepro.com/article/features/111822/the-10-worst-selling-consoles-of-all-time/>
- [13] S. Ferretti and M. Rocchetti, "Fast delivery of game events with an optimistic synchronization mechanism in massive multiplayer online games," in *Proceedings of the 2005 ACM SIGCHI International Conference on Advances in computer entertainment technology (ACE '05)*. ACM, 2005, pp. 405-412.
- [14] C. E. Palazzi, S. Ferretti, S. Cacciaguerra and M. Rocchetti, "A RIO-like technique for interactivity loss-avoidance in fast-paced multiplayer online games," *ACM Computers in Entertainment*, vol. 3, no. 2, April 2005.
- [15] M. Rocchetti, G. Marfia, and M. Zanichelli, "The art and craft of making the Tortellino: playing with a digital gesture recognizer for preparing pasta culinary recipes," *ACM Computers in Entertainment*, vol. 8, no. 4, December 2010.