VIRTUAL REALITY

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ABSTRACT

Recent years has seen the best period of development of the VR device. There were great improvement on the VR devices and the content which user can view. And more and more companies have realized the huge potential on it. Application of VR technology can be full of diversity, but currently it applied mainly in the field of video games. Nowadays, there are many tough problems in technic about VR, and therefore it requires a large investment. Though we cannot ignore the drawbacks on VR applications that it cost too much and not too much people can afford one. After taking into account the technical and legal risks, firmly seize this opportunity will be able to achieve huge success in commerce.
However, as no one could expect what would happen 10 years ago on the development of mobile phone while everyone was using the phone with real plastic keyboard. In the Future, VR will enter our everyday live, the market capacity will be inestimable.

1. INTRODUCTION

1.1. Prototype development

Half of a century from now, the first prototype facility of virtual reality technology appeared in the autumn of 1968. Nevertheless, virtual reality did not attract too much attention until recent years.

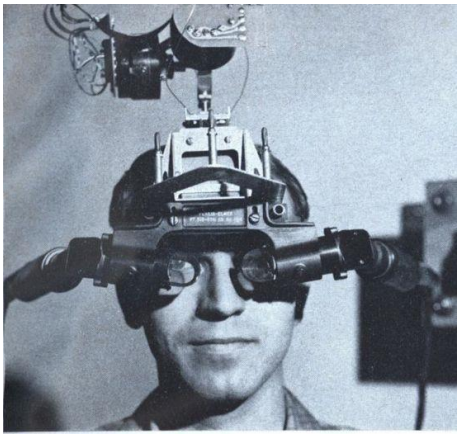

Figure1 (VR device)

(http://tech.163.com/15/0207/21/AHSMM1DG00094ODU.html)

"The Sword of Damocles" is widely considered to be the very first virtual reality system, which was created by computer scientist Ivan Sutherland in 1968. While using the device, the user had to have his head securely fastened with the device. [1]
Why people considered "The Sword of Damocles" as the first virtual reality system? Some vital features defined by this device have been followed for years. Such as:
Stereoscopic display
Virtual view generation
Head position tracking
Virtual environment interaction
Recent years have seen a significant achievement of the virtual reality. Not only we have high resolution in the stereoscopic display, high speed generation and rendition of virtual view, high accuracy of head tracking. We also have gesture recognition and speech control. Three dimensions model generation is no longer a difficult problem.

1.2. Features of VR

Virtual Reality is a modern high-tech with the help of computer science, which can generate specific lifelike virtual environment. What's more, user can interact with the object in the virtual environment and would be surrounded with immersive graphics.
Though nowadays there are many different types of virtual reality systems but they mainly share the same characteristics. They all have the ability to generate three-dimension images, which are appeared in life-sized, and provide immersive experience to the user. An ideal VR system should generate all the perception a human can feel and has a natural interaction with the user to make it lifelike. The virtual environment should respond to the user's actions in real time which means adjust the artificial alike reality.
Its main features are [2]:

- **Multi-Sensory:**

Expect the visual perception, the computers should have tactile sensing, motion sensing, even including taste, smell, perception and the like. Ideal virtual reality should have all the people with the sensing function.

- **presence**

Refers to the user feel as degree of simulating the real environment. Ideal simulation environment should enable

the user to be difficult to distinguish between true and false degree.

- **Interactivity**

It refers to the degree of user-operable objects within the simulation environment and natural degree feedback from the environment.

- **Autonomy**

It refers to the virtual objects in the environment based on the degree of real-world physical laws of motion actions.

Nowadays, there are different applications for virtual reality become practical, which include: entertainment, medicine, education, design and architecture. Virtual reality can lead to unbelievable discoveries in these aspects and result in enormous change in our daily lives.

2. CORE TECHNOLOGY

VR is a combination of different technology, including computer real time three-dimension image, stereoscopic display, user movement tracking, audio input/output, etc.

Computer real time three-dimension image

Though it is not a big deal for modern technology to generate sophisticated image, the key part is the image should appear in real time and be refreshed in high frequency. In VR system like flight emulator and racing car emulator, real time image is an essential feature as well as the quality of the image. It is not an easy job to achieve it.

- **Display**

In VR system, there will be some slight differences between the images seen by user's eyes. Some systems adopt single monitor, but after the user put on a pair of special glasses, one of his eyes can only see image shown in odd frame, the other eye can only see the image shown in even frame. The slight difference generates the amazing feeling of three-dimension.

- **User movement tracking**

VR system must be capable to track the movement of the user, especially the head and eyes, to make interaction possible. In an artificial environment, every object has a distinct position according to the coordinate system generated by the computer. The view seen by the user is decided by the position and the direction of the user's head and eyes. VR technology enables user to get rid of mouse and keyboard and control the change of view via the movements of his head. It is an innovative technology and provide vivid view to the users.

- **Sound**

Human can determine the direction of the source of the sound according to the difference of the phase and amplitude. Stereo used in cinema and theater relies on different soundtrack played in left and right hand side. In real life, when we spin our head, what we hear in surrounding environment will change accordingly. However, in VR system, due to the common appearance of the VR helmet, the direction of the sound source has nothing to do with the movement of user's head.

- **Feedback of the movement**

In a VR system, user can see a virtual object but cannot touch it. It would be a drawback when user wants to reach something but feel nothing. The common solution for this problem is to install some vibration devices in the gloves worn by the user to simulate the feeling of hands.

- **Speech Recognition**

In VR system, audio input and output is vital for the implementation of interaction with user. Translating speech in computer system remains a challenge, not only should it be efficient but the requirement of correct rate is high. By identifying the speaker before recognizing what he says can save some resource of the computer, but it also raises the requirement. [3]

Table1:Virtual reality technology requirements

Standard	Frame rate	Resolution	Compute capacity	Delay
Minimum	90HZ	2K	Qualcomm 820	≤19.3ms
Mature	100-120HZ	4K	upper	compress

Table1

3. VR APPLICATION

3.1. Application in entertainment industry

The surest forecast, according to the current situation of the development of VR technology, is that entertainment industry would be an essential application of VR and a powerful booster for VR from laboratory to market. [4]

Figure2(VR interactive)

（http://nyyezi.baijia.baidu.com/article/215216）

From the analysis of the scientific think-tank Digi-Capital, it is estimated that the market value of VR will go beyond 150 billion dollar by 2020. Entertainment VR alone, the market value would be 30 billion dollar, one fifth of the whole industry. [5]

Video showcase:

https://www.youtube.com/watch?v=uN9SoqvShtc

http://www.acfun.tv/v/ac778862

VR is widely used in entertainment industry which, however, is only the beginning of application of VR technology. VR can be seen gradually takes up position in the field of medicine, aerospace, education and tourism.

3.2. Cost of different product

More and more enterprises have got involved in VR industry since 2015. Currently there are more than 100 companies working on VR system development in China.
VR helmet is a key input device for VR experience. Many companies decide to work with computer hardware manufacturer to secure their share in the market. It is not strange to spend tens of thousands of dollar on top hardware to manufacture a good helmet. [6]

Oculus Rift

Cost: More than 1600 US dollar

Figure3(Oculus Rift)

(http://news.52pk.com/shtml/20160122/6639828.shtml)

To run a Oculus Rift, the user needs a PC at least be equipped with Intel Core i5-4590 processor, 8GB RAM, Nvidia GTX 970 or AMD R9 290 Graphics Card, a HDMI port, three USB 3.0 port and one USB 2.0 port with a OS undated above Windows 7.

Sony PS VR

Cost: More than 912 US dollar

Figure4(PS VR)

(http://news.52pk.com/shtml/20160122/6639828.shtml)

Sony PS VR is an video game accessory and only support PS4 which means user without PS4 cannot use it. [7]

Storm Mirror 4

Cost: Less than 30 US dollar (only in China)

Figure5(Storm Mirror)

(http://www.mojing.cn/)

Storm Mirror 4 use a new structure of suspended wearing which is a minimalist design and more compact form, better balance. So that the force of head is more evenly, while also effectively to reduce the oppression on face. It can effectively alleviate the long-term wear occurs fatigue and wear more comfortable. Storm 4 uses FOV96 ° lens, to improve resolving, while increasing the clarity of the regional center of the lens, to reduce edge blur and effectively prevent the "Vertigo."
But the device is not easy to carry, thermal performance is also to be improved.
Overall, it is higher cost performance [8]

3.3. Content

More and more video games accept VR device as accessory. They may be the pioneers of a new industry

Figure7(Rush Blood)

(http://games.qq.com/a/20160115/028027.htm)

Besides video game, video itself is another famous content of VR. Google has been working on the production of VR video and post it on Youtube channel and encourage its user to watch it in smartphone with Google Cardboard. [9]

Figure6(Before Zuckerberg Speaking, people experience VR)

(http://news.sina.com.cn/w/zg/2016-02-24/doc-ifxprucu3174992.shtml)

Facebook believe that there is huge potential in VR social and they will achieve the goal to make people worldwide to experience virtual party one day. [10]

4. FINANCIAL ANALYSIS

Naturally, there are cheap alternatives like Google Cardboard, but to achieve an awesome experience on VR technology, good VR hardware cannot be ignored. The cost to the hardware is not a cost that can be underrated. Only the head-wear device may cost user hundreds of dollars. Though, due to the development of VR technology, the price of it will drop down gradually. The essential part to make profit should be the software and its corresponding content.

With more and more customer paying close attention to the VR development, there will be no doubt a bright future for VR.

4.1. Market expectation

According to a report from analyst firm SuperData Research data show that until the end of 2016, VR product users will reach 3.89 million, while VR market is expected to reach $ 5.1 billion. It is expected that 2016 will be the first European market VR products will reach $ 1.9 billion, the size of the market in North America was $ 1.5 billion, followed by the Asia market will reach $ 1.1 billion, plus the above-mentioned areas Rest of the world $ 600 million, in 2016 the total market size of VR up to $ 5.1 billion.

It is worth mentioning that in 2016 the market size of VR 7.7 times bigger than $ 660 million in 2015, the analysis also pointed out that in 2017 this figure will jump to $ 8.9 billion, while in 2018 will reach 123 billion. [11]

According Manatt Digital Media released a report. In 2020, VR / AR market will reach $ 150 billion. CCS Insight predicts that by 2020, VR / AR equipment sales will reach 97 million units. [12]

4.2. Market situation

- **The homogenization of serious**

2014 I / O conference, Google launched a box called Cardboard, and since then, it has been found in domestic and overseas markets a variety of VR glasses. Products are numerous, but after reading it again it is difficult to impress, the most fundamental reason is that the VR glasses content is almost the same.

- **The lack of core competitiveness**

Experience is bad. There is only appearance, not high-tech and even basic functional design has serious flaws.

4.3. Competition analysis

- **Oculus Rift propaganda strong**

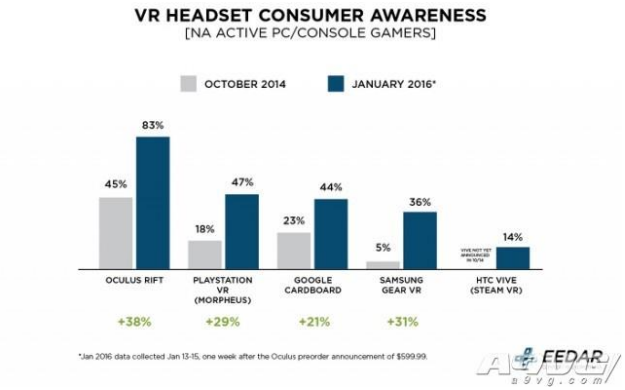

Figure7

(http://www.a9vg.com/201601/1023860311_all.html)

Since August 2012 the crowdfunding start, Oculus Rift VR has been occupying the headlines related forum, and soon reached its crowdfunding budget targets. In March 2014, Facebook acquired Oculus company. Due to these publicize public events, there are 45 percent of US computer or a host of players expressed understanding Oculus Rift in EEDAR 2014. This beyond any other VR products. And today, eight American players have heard of the name of the Rift.

- **PlayStation VR dominant in the price**

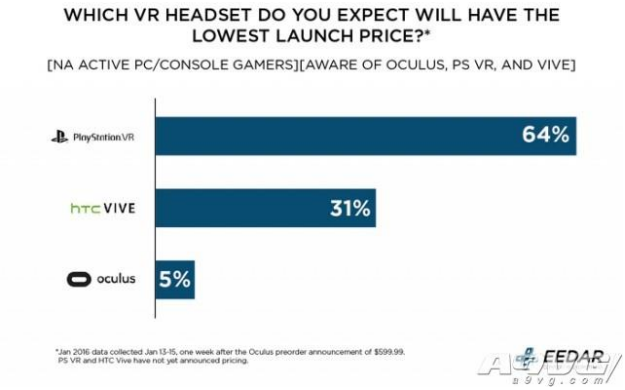

Figure8

(http://www.a9vg.com/201601/1023860311_all.html)

PlayStation VR price will be lower than its competitors. 64% of the players think PlayStation VR will be the most affordable price in three major manufacturers of products. This is mainly because Sony has many experience in hardware production, as well as its use of PS4 host share the processing function to reduce costs.

- **Oculus Rift headset is the most functional equipment**

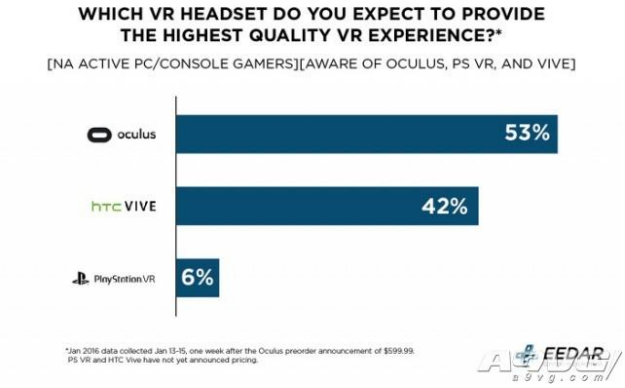

Figure9

(http://www.a9vg.com/201601/1023860311_all.html)

Palmer Luckey insisted that the target markets of Oculus is different from PlayStation VR, not only because it needs a PC as a carrier, the other PC as a carrier, on the other hand is the advantage that the performance about Oculus is high. According to the powerful propaganda, the data show that more than half of the players thought that Oculus Rift will be the highest function of the three products.

- **players constantly adjust the price expected**

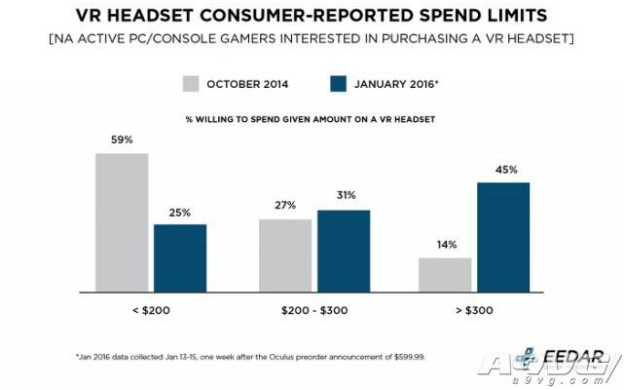

Figure10

(http://www.a9vg.com/201601/1023860311_all.html)

In October 2014, only 14% of the players are willing to spend on a headset over $ 300 more than a year later the figure reached nearly half. From now on, VR headset device will be priced more than 300 US dollars, and its target population and not just the early pioneers of the mass consumer, but these data may also show the players can expect for the price change. [13]

4.4. patent analysis

Patent ownership analysis

US holds patents accounted for 67.7%, Japan accounted for 17.5%, together accounting for up to 85.2%. Obviously, the United States and Japan leading virtual reality technology trends. If vendors want a technical cooperation or technology development, they should pay special attention to the United States, Japan Patent Trends and virtual reality layout trends.

Industry analysis

Overall, patents and virtual reality application projects, concentrated in gaming entertainment device, display system, man-machine interface, control systems, image analysis, communications, computer data transmission multiple (cloud computing), television and education.

Patent portfolio focused on applications (45.7%), audio-visual system (37.9), data processing (6.0%) and other categories, the proportion of the total as high as 89.6%.

Among them, applications to games based entertainment device, audio-visual system to display-based system, to control the data processing system based. [14]

Analysis of important patents in virtual reality

Use your smartphone to do virtual reality helmet display device.

US startups Merge Labs, Inc. on November 3, 2015, to get a virtual reality helmet display device approved by the United States Patent US 9176325. The patented technology focus:

The main consists of the mobile computing devices helmet display system is waterproof material. At the same time, it is space for mobile computing devices, which will be placed therein. The main internal configuration a pair of lenses and lens focus image corresponding to each screen mobile computing devices. You can configure a button on the device body. The user presses the button to start the mobile computing device in response to the touch screen.

Obviously, there are many manufacturers introduced similar patented virtual reality helmet display products such as Google Cardboard Virtual Reality 3D viewing boxes and the like Samsung Gear VR.

According to All Element Rule judge whether these two products may constitute patent infringement. Preliminary product comparison Samsung Gear VR may be patent infringement.

However, Google Cardboard Virtual Reality 3D viewing box is not possible patent infringement. The main reason for the Google Cardboard virtual reality body is constituted by a cardboard instead of waterproof material, and therefore does not meet the full requirements principle. [15]

5. RISKY AND PROBLEMATIC

Health risk

Some people may feel sick when they experience VR for first time. [16] Simulator sickness, refers to the uncomfortable feeling when people using VR devices, can be an obstacle to popularize VR. However, when three-dimensional video game was first introduced to the market, it was controversial either. People criticized it because they feel sick when they watch the view spin a lot on the screen. But users soon adopted it and the game producer made a considerable profit from it. Grand Theft Auto series, for example, are one of the most successful three-dimensional video games and have got large benefit from the improvement of video games. It is full of expectancy to see who may be the next to have such an achievement in newly built VR market. [17]

Legal risk

Once VR content became countless, it is not easy to put every piece of content under surveillance. In the future, VR service provider should enhance censorship of the VR content to avoid any possible legal issue.

6. ABOUT THE PROSPECT

VR will give user much freely experience without the restriction of cable and PC. It can be foreseen that the cost of the device will eventually decrease after long term development. Cheap and carriable VR device may lead to great change of our lives. [18]

In the near future, mankind has been an important development in the field of nerve. Virtual reality will probably get rid of a heavy burden on the hardware, connect directly to the nerve, connecting everything! This is truly immersive and interactive. Connecting everything, we will truly enter the era of the Matrix.

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