Virtual Reality



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EXECUTIVE SUMMARY

Virtual Reality (VR) is one of the most widely discussed concepts in today's technology circles. Virtual reality headsets have the potential to make a significant change in the way consumers work, experience entertainment, make purchases and participate in social activities. With applications and opportunities in the 3D/4D technology market, Virtual Reality is expected to be a far-reaching technology in the next 10 years.

In this report, we study the technological landscape of this technology from the perspective of Intellectual Property (Patents). We find that the majority of patenting activity under this technology has occurred in technologies related to 'Interface Arrangements', '3D modeling' and 'Data Processing'. Sony is the top patent filer in the virtual reality domain followed by Microsoft and Samsung. United States has seen the maximum patent filings and is closely followed by South Korea and China.

Using our proprietary patent analytics tool, LexScore[™], we identify Sony, Samsung and Microsoft as the leaders in this technology domain, having a high quality patent portfolio as well as a frequent patent filing activity. Patent holding pattern, coupled with high patent filing activity, shows a significant patent licensing potential in this technology domain. Using our proprietary Licensing Heat-map framework, we predict significant patent licensing activity in the 'Data Processing' technology segment in the near future.

In the following sections, we present our analysis of the Patent Landscape of this technology domain.



Introduction

Virtual reality is used to describe a three dimensional computer generated environment which is immersive and can be explored and correlated by a person. One becomes part of this virtual world or is occupied within this environment and while there, is also able to operate objects or perform a series of activities. Virtual reality can recreate sensory experiences, which include virtual taste, sight, smell, sound, and touch.

Today 3D and 4D technologies are getting increasingly popular. There is a trend towards its integration with industries like manufacturing and healthcare along with its dominant presence in entertainment industry. With the advancement in technology, the applications and opportunities in the 3D/4D technology market have gradually increased to areas such as industrial, consumer, entertainment, healthcare, education and defense. Over the last few years, the number of 3D movie releases has increased significantly; thus, the demand for 3D TVs has also increased, making the '3D TV', a major market segment in the 3D technology market in terms of revenue and market share. The revenue generated by the 3D and 4D technology market in 2013 was \$93.21 billion, and is expected to grow up to \$279.27 billion by 2018 and further to \$470.86 billion by 2020, at an estimated CAGR of 26.84% from 2014 to 2020. This rise of 3D technology and its applications in various sectors led to the rise of various virtual reality display systems. The very first idea of it was presented by Ivan Sutherland in 1965, when he created the first virtual reality head-mounted display system.

There has also been an increase in interest in the potential social impact of virtual reality technology. Today, virtual reality (VR) headsets might be considered the latest breakthrough in modern technology, with 360-degree interactive environments facilitating human-like avatars. Virtual reality headsets have the potential to make a significant splash in the way consumers work, experience entertainment, make purchases, and participate in social activities. According to a Kzero report, the consumer virtual reality market, including hardware and software is forecast to be worth US\$5.2 billion worldwide by 2018. The sales of virtual reality hardware devices are estimated to grow from 200,000 units in 2014 to 5.7 million units in 2015 and 23.8 million units in 2018.

The virtual reality revolution accelerated in in 2012 when Palmer Luckey developed an immersive virtual reality headset known as the Oculus Rift. The Oculus Rift was the first product to reinvigorate the VR industry with a Kick starter campaign that raised almost 10 times more than it was seeking, closing with \$2.4 million in August 2012.

The growing importance of virtual reality in industry has led to extensive research in this area and as a result, big companies such as Intel, Nokia and Finland's University of Oulu announced that they are developing a joint

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Samsung filmed a birth in virtual reality so the father could watch the birth of his son from thousands of miles away.

Research firm Gartner, projects that 25 million headmounted VR headsets will be sold world-wide by the end of 2018, mostly in developed markets such as the U.S. and Europe. research center to create software for 3D and virtual reality experiences for use on mobile devices. Initially, the lab will conduct research on developing new and compelling mobile user experiences using 3D and 4D technology. Creating interfaces that are more similar to interactions in the real world can enable experiences that are more natural and intuitive, in the same way that modern games and movies are more immersive through the use of realistic 3D graphics. Also, IBM research activities have led to the development of a mobile app incorporating virtual reality for British grocery retailer Tesco, which allows their employees to determine better product placement by capturing images of store shelving space and superimposing those with images of the products that should be placed on those shelves.

Medical applications for virtual reality are just starting to emerge. These consist of VR surgical simulators, telepresence surgery, complex medical database visualization, and rehabilitation. The Green Telepresence Surgery System consists of two components, the surgical workstation and remote worksite. At the remote site there is a 3-D camera system and responsive manipulators with sensory input. At the workstation there is a 3-D monitor and dexterous handles with force feedback. The VR surgical simulator is a stylized recreation of the human abdomen with several essential organs. Using a helmet mounted display and Data Glove, a person can learn anatomy from a new perspective by 'flying' inside and around the organs, or can practice surgical procedures with a scalpel and clamps. Database visualization creates 3-D images of complex medical data for new perspectives in analysis.

Virtual Reality can also be a great boon to the average level of wisdom present across the world. Life is the process of gaining perspective through experience. This eventually brings calmness and wisdom. And now, by giving young people access to a range of life experiences through the power of VR, it's possible that we'll be able to give the youngest in our society a bit of perspective and grounded wisdom starting at a very early age. Just imagine a future where it will be easy for young people to experience and understand, in a manner more intuitive than is possible with book or video or traditional methods.

In early 2015, Sony revealed a new virtual reality headset for its PlayStation 4 console named "Project Morpheus." By projecting real-time images in front of gamers' eyes and tracking their head movements, Project Morpheus delivers a one of a kind virtual reality experience, which could help Sony improve console sales. The console wars between Sony and Microsoft have been fierce, and with Sony's latest announcement, both companies could be competing over best virtual reality enabled console over the next few years.

Windows Holographic is a virtual reality computing platform created by Microsoft that is set to be introduced in the Windows 10 operating system upon its release in 2015. The device for Windows Holographic is Microsoft HoloLens which is a smart glasses unit and uses advanced sensors, a highQualcomm has joined Google and others in a \$542 million funding round for Florida startup Magic Leap, which is working on virtual reality technology.

HTC-Vive raked in 187.95 billion New Taiwan dollars (US\$5.98 billion) in revenue last year, off 8% from a year earlier. In the fourth quarter of last year, the company's revenue increased 12%, after swinging to a net profit in the second quarter. definition 3D optical head-mounted display, and spatial sound to allow for virtual reality applications, with a natural user interface that the user interacts with through gaze, voice, and hand gestures.

As market players compete to realize the huge economic potential offered by the virtual reality, we have seen a flurry of M&A activity in this domain. Facebook's \$2 billion acquisition of Oculus VR is the biggest transactions in this domain yet. Qualcomm has joined Google and others in a \$542 million funding round for Florida based startup, Magic Leap. It is working on a head-mounted device, which superimposes 3D computer-generated imagery over real world objects, by projecting a digital light field into the user's eye. Further, Samsung partnered with Vortex VR to create a \$100 mobile VR headset that uses LG's G3 Quad HD smartphone as its display.

In such a financially lucrative and fast evolving market safeguarding a company's interest using Intellectual property is an important strategy for market players. Assessing the IP landscape is therefore an important exercise for current market players as well as companies who are looking to enter this market.

According to Kzero report, the consumer virtual reality market, including hardware and software is forecast to be worth US\$5.2 billion worldwide by 2018 and particularly, sales of virtual reality hardware devices are estimated to grow from 200,000 units in 2014 to 5.7 million units in 2015 and 23.8 million units in 2018.

Taxonomy

Virtual reality is an artificial environment that is created with software and presented to the user in such a way that the user suspends belief and accepts it as a real environment. The simplest form of virtual reality is a 3-D image that can be explored interactively at a personal computer, usually by manipulating keys or the mouse so that the content of the image moves in some direction or zooms in or out. More sophisticated efforts involve such approaches as wrap-around display screens, actual rooms augmented with wearable computers, and haptic devices that let you feel the display images. Image Data Processing and 3D Modeling are essential computing systems in virtual reality display devices. The categorization of patents and patent applications in the area of virtual reality was done on the basis technical/functional components and their application areas. The set considered for the analysis comprises of 11,776 patents/patent applications. The level-1 categories are computing, system, application, medical and control system. The broad level 1 categories are further subdivided into level 2 sub-categories.

In the 'Computing/Processing Techniques' Category, the following seven subcategories are of interest: 'Data Processing', 'Data Transferring', 'Image Data Processing', 'Data Security', '3D Image Rendering', '3D Modeling' and 'Error Detection'. There are 1,646 patents/patent applications in 'Data Processing', 861 in 'Data Transferring', 1,308 in 'Image Data Processing', 83 in 'Data Security', 768 in '3D Image Rendering', 1,727 in '3D Modeling' and 53 in 'Error Detection'.

In the 'System/Device' Category, the following six sub-categories are of interest: 'Stereoscopic Devices', 'Audio Devices', 'Interface Arrangements', 'System Architecture', 'Display Devices' and 'Processing Devices'. There are 520 patents/patent applications in 'Stereoscopic Devices', 365 in 'Audio Devices', 2,041 in 'Interface Arrangements', 62 in 'System Architecture', 1,427 in 'Display Devices' and 634 in 'Processing Devices'.

In the 'Other Applications' category, E-Commerce, Education, Gaming and Optics are the main focus areas; with 1,524, 1,130, 766 and 738 patents filed respectively. Sports has seen significant activity with 630 patent filings in the last few years. Virtual Reality is a great boon to the education sector, now people can get access to a range of life experiences through various VR devices. Virtual Reality has revolutionized the gaming industry. Virtual reality gaming is where a person can experience being in a three-dimensional environment and interact with that environment during a game.

In the 'Medical Applications' category, 'Medical Devices' and 'Identification' are the main focus areas; with 630 and 369 patents filed respectively. Virtual reality technology enables the user to learn about the human anatomy by using a helmet mounted display and Data Glove ('Medical Devices') as The Oculus Rift first jolted the VR industry back to life with a Kick starter campaign that raised almost 10 times more than it was seeking, closing with \$2.4 million in August 2012.

Video game makers have started using virtual reality in various ways to enhance the gaming experience. New controllers from companies such as Nintendo, Microsoft and Sony enable players to interact with games by tracking real movement in 3D space, providing a more intuitive. natural and overall fun gaming experience.

database visualization creates 3-D images of complex medical data for new perspectives in analysis.

Optical Control Systems and Elec. Control Systems form the key focus areas under 'Control System' with 923 and 338 patents filed respectively.

Level 1	Level 2	Total Documents
	Data Processing	1646
	Data Transferring	861
Computing/ Processing	Image Data Processing	1308
	Data Security	83
Techniques	3D Image Rendering	768
	3D Modeling	1727
	Error Detection	53
	Stereoscopic Devices	520
	Audio Devices	365
System/Davias	Interface Arrangements	2041
System/Device	System Architecture	62
	Display Devices	1427
	Processing Devices	634
	Optical Control Systems	923
	Elec. Control Systems	338
Control System	Time-based Control Systems	151
	Other Control Systems	126
	Audio Control Systems	47
	Identification	369
Medical Applications	Medical Devices	630
medical Applications	Surgery	69
	Therapy/Exercise	95
	Gaming	766
	E-Commerce	1524
	Optics	738
	Speech Recognition	616
Other	Education	1130
Other	Advertising & Management	355
Applications	Navigation	480
	Sports	630
	Photography	160
	Safety	182
	Testing	35

Figure 1: Taxonomy



Top Assignees

The figure below shows assignees with the maximum number of patents/patent applications related to virtual reality. Sony, Microsoft and Samsung are the top 3 patent holders in this domain with 366, 365 and 348 patents/patent applications respectively. The distribution of patents/patent applications is very fragmented with the top holder having around 3% of the total patent filings. Such distribution, along with the presence of NPEs like ETRI & Intellectual Ventures, is indicative of the fact that there is a huge scope of cross patent licensing and litigations in the field of Virtual Reality...

The top assignees have actively filed patents/patent applications in subdomains such as '3D Modeling', 'Data Processing', 'Display Devices', 'Image Data Processing', 'Interface Arrangements' and 'Processing Devices' while they seem to have shown indifference towards 'Medical Devices', 'Identification', 'Sports', 'Surgery', 'System Architecture' and 'Data Security'. Microsoft's windows Holographic is a virtual reality computing platform that is set to be introduced in the Windows 10 operating system upon its release in 2015.





GEOGRAPHICAL COVERAGE

The figure below represents the geographical filing trend of patents/patent applications related to virtual reality. The United States has seen maximum number of patent filings in domain of virtual reality. South Korea and China have also seen good number of patent filings

Top patent filers like Microsoft and Sony have filed most of its patents related to virtual reality in the US which is quite evident from the research going on in the country.

NPE like Intellectual Ventures have also filed most of its patents related to virtual reality in the US.



Figure 3: Geographical Coverage Map

NASA, the Department of Defense and the National Science Foundation funded much of the research and development for virtual reality projects. The CIA contributed \$80,000 in research money to Sutherland.



LexScore™

We use LexInnova's proprietary LexScore[™] framework to identify leading contributors to virtual reality technology, from the intellectual property perspective. The figure depicts the competitive positioning of top 15 assignees in the virtual reality domain. The assignees are compared on the basis of number of and quality of patents/patent filings. We use our proprietary algorithm (based on bibliographic information and claim characteristics of an invention) to determine the quality of inventions.

The green region comprises assignees with the best patent portfolios, which are exemplary in terms of quality and number of patents. Sony is the only assignees lying in this domain and it can be assumed that it dominates this technology in terms of intellectual property. Samsung, Qualcomm and Microsoft lie in the orange region, that contains assignees with high number of patents in portfolio but somewhat lacking in quality. Samsung is almost at the border of green and orange regions indicating that it is posing a tough competition to Sony.

The blue zone comprises entities, which have a good patent portfolio in terms of quality but lack numbers on filing front. IBM has a very good overall technology coverage and citation score but lags in number of filings in this domain. Intellectual Ventures and Nokia are at the border of red and blue regions indicating that these companies also have the ability to move into the Leadership zone by increasing their filing activity.



Samsung partnered with Vortex VR to create a \$100 mobile VR headset that uses LG's G3 Quad HD smartphone as its display.

LG is teaming up with Google for its new "VR for G3" giveaway that'll see LG G3 buyers get a free VR headset that works with Google Cardboard.



The red zone, or 'slowcoaches' zone, captures companies that have both low quality and low number of patents/patent applications. They should prioritize their R&D on the development of quality intellectual portfolio as well as increase their filing activity. Also SK Telecom, owing to its low number of granted patents, poor geographic filing features lies at the bottom in LexScore.

Licensing Heat Map

We use a Licensing Heat-map framework to identify technology sub-domains in the field of Virtual Reality where licensing activity is expected to be higher. The size of the box of the domains (Level 2 categories) indicates the number of patents filed in this domain, which in a way represents the relative importance of the technology sub-domain. The color of the box represents the chances of future licensing activity in this domain. We study the patent holding pattern in the respective technology sub-domain to predict the future licensing activity.

Red color (and shades thereof) signifies a high chance of licensing activity in a certain technology sub-domain whereas the lighter shades represents a relative low chance of licensing activity in the technology sub-domain. We follow 80-20 rule to decide the colors, yellow is assigned to the domains that lie on the average case (i.e. 20% assignees having 80% of the patents/patent applications). The color drifts towards shades of red if 20% assignees possess less than 80% of the patents/patent applications, while it drifts towards shades of green in the reverse case. The figure 6 below shows the analysis of the top 10 technology sub-domains in terms of number of patents filed.



Figure 5: Licensing Heat Map

'Data Processing' is a computing method specially adapted for administrative, commercial, financial, managerial, supervisory or forecasting purposes by sensing the record carriers. Sony, Qualcomm, Samsung and Nokia are some of

Korean electronics giant fires the latest shots at rival Apple with newly designed flagship smartphones, a mobile payment system, and a virtual reality headset.

Sun Microsystems emerges as one of the early buyers of IP assets in virtual reality technology, acquiring patents from VPL Newco Inc. in 1997. the companies that hold patents/patent applications related to data processing. '3D Modeling' is a computer graphics technique used for manipulating the 2D/3D models. This domain will see relatively less number of litigations in the future.

The very first idea of VR display systems was presented by Ivan Sutherland in 1965, when he created the first virtual reality headmounted display system.



Breakthrough Products

In early 2015, Sony revealed a new virtual reality headset for its PlayStation 4 console named as "Project Morpheus". ¹By projecting real-time images in front of gamers' eyes and tracking their head movements, Project Morpheus delivers a one of a kind virtual reality experience, which could help Sony improve console sales. Sony is top filer of patents in the virtual reality domain.

Microsoft has also actively filed in virtual reality domain and occupies second spot after Sony. Windows Holographic is a virtual reality computing platform created by Microsoft that is set to be introduced in the Windows 10 operating system upon its release in 2015. The device for Windows Holographic is Microsoft HoloLens which is a smart glasses unit and uses advanced sensors, a high-definition 3D optical head-mounted display, and spatial sound to allow for virtual reality applications, with a natural user interface that the user interacts with through gaze, voice, and hand gestures.

The most popular product in virtual reality domain is Oculus Rift which is an immersive virtual reality headset. The Oculus Rift was the first product to reinvigorate the VR industry with a Kick starter campaign that raised almost 10 times more than it was seeking, closing with \$2.4 million in August 2012². In March 2014, Facebook agreed to acquire Oculus VR for US\$2 billion in cash and Facebook stock.

Samsung, Qualcomm and LG are the other top assignees in the virtual reality domain. Samsung made a partnership with Vortex VR to create a \$100 mobile VR headset that uses LG's G3 Quad HD smartphone as its display. Qualcomm's Vuforia platform for Digital Eyewear Software development kit (SDK) builds open the original Qualcomm Vuforia mobile vision platform³, which was focused on enabling virtual reality for mobile development. The new SDK actually combines the two, using the camera fitted to the Galaxy Note 4, housed within the Gear VR, as a follow-through device to create even more convincing VR experiences. LG is teaming up with Google to try bringing virtual reality to the masses with its product- the VR for G3⁴. It's a Google's Cardboard-inspired headset that turns the LG G3 into a virtual reality display. The G3 slots into the VR headset and uses Google software to create a virtual reality environment, and it features a special "neodymium ring magnet" that uses the phone's gyroscope to let users control it without touching the display.



Figure 6: Sony Morpheus



Figure 7: Microsoft Hololens



Figure 8: Oculus Rift

¹ <u>http://www.techradar.com/reviews/gaming/project-morpheus-1235379/review</u>

² <u>http://www.tomsguide.com/us/what-is-oculus-rift,news-18026.html</u>

³ <u>http://www.qualcomm.eu/products/augmented-reality</u>

⁴ <u>http://www.lg.com/au/press-release/lg-g3-brings-mobile-virtual-reality-to-australia</u>

Appendix

Taxonomy Heads	Definition
Data Processing	The inventions in this category cover data processing techniques. They are computing methods mainly adapted for administrative, commercial, financial, managerial, supervisory or forecasting purposes by sensing the record carriers.
Data Transferring	The inventions related to this category cover data transferring techniques. They are methods where data is transferred from one type of record carrier to another type.
Image Data Processing	The inventions related to this category cover image data processing techniques. In these processes, images are enhanced or transformed.
Data Security	The inventions related to this category cover data security arrangements. These are the security arrangements for protecting computers and various components like programs or data against unauthorized activity.
3D Image Rendering	The inventions related to this category cover 3D image rendering techniques. These are the 3D computer graphic processes which automatically convert 3D wire frame models into 2D images using 3D photorealistic effects or non- photorealistic rendering.
3D Modeling	The inventions related to this category cover 3D modeling techniques. These are used for manipulating 3D models or images for computer graphics.
Error Detection	The inventions related to this category cover error detection methods. These cover various types of error detection techniques like methods for verification of the correctness of markings on record carriers, arrangements for testing electric properties and locating electric faults.
Stereoscopic Devices	The inventions related to this category cover various stereoscopic devices. These are the devices for creating or enhancing the illusion of depth in an image by means of stereopsis for binocular vision.
Audio Devices	The inventions related to this category cover various audio devices/stereophonic arrangements. These are the devices for protecting against damping, noise or other acoustic waves.
Interface Arrangements	The inventions related to this category cover various interface arrangements. These are various output arrangements for transferring data from processing unit to output unit.
System Architecture	The inventions related to this category cover the architecture of the computing system. These are computer systems based on specific computational models and are used for accessing, addressing or allocating memory within memory systems or architectures.



Display Devices	The inventions related to this category cover various display devices. These are the devices for displaying the visual content to the user from servers or any other video source.
Processing Devices	The inventions related to this category cover various processing devices. These are digital computers, data processing equipment and multiprocessor systems which are used to process data.
Gaming	The inventions related to this category cover various gaming applications. Video games that use an electronically generated virtual reality display systems having two or more dimensions.
E-Commerce	The inventions related to this category cover payment architectures, transactions, and applications.
Optics	The inventions related to this category cover various applications in optics. These are holographic processes or apparatus which use light, infra-red, or ultra-violet waves for obtaining holograms or an image.
Speech Recognition	The inventions related to this category cover speech recognition techniques like voice processing, voice coding/decoding, etc.
Education	The inventions related to this category cover applications in the education sector. It covers simulators for teaching or training purposes.
Advertising & Management	The inventions related to this category cover applications in advertising & management. It refers to combined visual and audio advertising or displaying and various management techniques.
Navigation	The inventions related to this category applications in navigation. These cover navigational instruments for measuring distance traversed on the ground by a vehicle, location tracking, etc.
Sports	The inventions related to this category cover applications in sports. These cover training appliances or apparatus for special sports like training of parachutists.
Photography	The inventions related to this category cover applications in photography. These contain photosensitive materials or processes for photographic purposes and apparatus for processing exposed photographic materials.



Safety	The inventions related to this category cover applications in safety. These are alarm systems which are responsive to a single specified undesired or abnormal condition.
Testing	The inventions related to this category cover applications in testing. These are used for testing of vehicles and also used for testing elastic properties of bodies or chassis, e.g. torsion-testing and testing alignment of vehicle head-lighting devices.
Identification	The inventions related to this category cover applications in identification. These are used for analyzing biological material and used for diagnostic purposes with the help of ultrasonic, sonic or infrasonic waves.
Medical Devices	The inventions related to this cover various medical devices. These contain apparatus or methods for oral or dental hygiene and also cover devices for producing or ending sleep by mechanical, optical, or acoustical means, for e.g. Hypnosis.
Surgery	The inventions related to this category cover applications in surgery. These contain various techniques & devices used for surgery.
Therapy/Exercise	The inventions related to this category cover applications in therapy/exercise. These include radiation therapy used for diagnosis by applying radioactive material to the body etc. and various exercises used in rehabilitation.
Optical Control Systems	The inventions related to this category cover optical control systems. These are the devices or arrangements used for the control of the intensity, color, phase, polarization or direction of light arriving from an independent light source, e.g. switching, gating or modulating.
Elec. Control Systems	The inventions related to this category cover electrical & electronics control systems. These are the arrangement of elements of electric circuits.
Time-based Control Systems	The inventions related to this category cover time-based control systems. These are the systems used for marking or sensing record carriers with digital information and also contain time-program switches which automatically terminate their operation after the program is completed.
Audio Control Systems	The inventions related to this category cover audio control systems. These are used for information storage on discs or tapes and also cover various broadcast systems for the distribution of stereophonic information.
Other Control Systems	The inventions related to this category cover control systems other than the above mentioned control systems.
	Table 1: Taxonomy Definitions



ABOUT US

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