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Virtual Reality and Augmented Reality: upcoming consumer and business powertool

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Both technical and consumer trends are pointing to the possibility of Virtual Reality (VR) becoming the next mass consumer and business applications power tool. A related technology, Augmented Reality (AR), is expected to follow suite soon.

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In this year's Consumer Electronics Show (CES) in Las Vegas, USA, one of the hottest subjects talked about was Virtual Reality (VR). With Oculus Rift announcing the release of its first consumer version and HTC Vive also introducing its newest model, the tech hype surrounding VR is growing from last year[1]. It is not only the bleeding-edge techies and gamers that are interested either – a recent story[2] talks about a doctor who was able to save a baby's life thanks to Google's US$20 VR headset, "Google Cardboard". Both technical and consumer trends are pointing to the possibility of Virtual Reality (VR) becoming the next mass consumer and business applications power tool. A related technology, Augmented Reality (AR), is expected to follow suite soon.

CES 2016 in Las Vegas, USA (Source: https://www.flickr.com/photos/lge/23935828019/)

VR refers to the use of computer technology to create a simulated environment[3]. Imagine looking through goggles that place you in different world (VR goggles are non-transparent to the outside world, that is, they create a new reality for the user). Augmented Reality (AR), on the other hand, refers to the use of computer technology to simulate artificial objects in the real environment[4] (AR goggles are transparent, that is, they combine artificial imagery with

the real surroundings; imagine having a layer of simulated elements and guidelines projected on top of what you see in the real world). In this article, we will look at the industry dynamics, applications and predictions, and business suggestions for both VR and AR.



People using the VR and AR technology

Technology fueled by rapid advances of display technology, graphic cards and software

It is no coincidence that VR and AR have come to the center-stage of the tech hype recently; much of the underlying technology is identical to smartphones, which have gone through a rapid cycle of development. Competition in the smartphone industry has driven the cost of extremely high pixel density screens down to commodity prices. The same can be said for motion sensors and gyroscope sensors (sensors that detect the orientation of a device). Another major advance has been Moore's law applied to graphics processing units (GPUs). Only recently have GPUs – mainly fueled by demand in gaming – become powerful and efficient enough to meet the high refresh rates and resolutions that virtual reality requires. Without advanced GPUs, VR applications would cause motion sickness[5]. The combination of technological advances in smartphones and gaming has also served to unleash VR potential.

However, there are a number of new technologies specific to VR as well, such as 3D/360 cameras, haptics (providing sensory feedback to the user), 3D lenses and position trackers. While the exponential advances in display technology and graphic cards has fueled the development of VR and AR, the overall bill of materials is still somewhat pricey due to these components. This is expected to change in the coming years, and with that adoption is likely to accelerate further.

While VR devices and applications are being introduced to the public, we have yet to see a mass-consumer-ready AR devices appear in the same manner. The reason is simple – the technology is just not ready yet. An honorable mention of the late Google Glass is inevitable, but experts tend to regard it more as a "computer projected on glass" rather than "true AR"[6]. AR technology is slightly more difficult to develop, as it requires the device to both fully detect the surrounding environment and at the same time seamlessly add a virtual reality layer on top of it. Additional technologies required include accurate calibration of surroundings, and advanced display technologies which will enable full integration of graphic images and the user's true environment. For calibration of surroundings, companies are investigating laser measurement to determine the depth and relative distance of surrounding objects[7]. For AR head-mounted display (HMD) technologies, fiber optic projection is being studied as a cheaper and lighter alternative to LCD or OLED panels[8].



Structure and principle of LG OLED panel (Source: http://www.lgoledlight.com/)

The race towards mass-adopted consumer and business applications

As core technologies for an interesting VR or AR application are more or less available, the next step is to assemble these into an appealing product for the target customer, and to drive down cost by economies of scale.

VR is already in the process of being introduced to the end consumer with multiple companies bringing working solutions to the market. The price point is still somewhat high for most of the products, but expected mass adoption and economies of scale is bound to drive that down. The Business-to-Consumer (B2C) applications of VR are more geared towards entertainment (games and media). More and more VR content is also being made available, spanning from movies to news media, and this can be expected to support the VR entertainment trend[9][10].

VR devices can be categorized by their price point – low-end mobile based devices and high-end gaming-centered devices. In the lower end of the spectrum, price for devices (excluding the mobile phone component) ranges approximately between US$20 and US$200. There exists Google Cardboard (price US$20-60, depending on manufacturer), LG's VR for G3 (price unknown; which also uses Google software), and Samsung Gear VR (price US$199.99; powered by Oculus). While somewhat lacking in sophistication, these mobile-based devices are a low-cost investment for trying out VR. In fact, Google Cardboard is such a low-cost investment that the New York Times distributed it to all its Weekend edition subscribers to promote its new VR content[11]. Google Cardboard is also being used in schools (a program called Expeditions[12]) to provide a new level of immersive education. This tier of VR devices provides an easy route for people to try out and experiment with VR. It is also being used for some experimental marketing – examples include Volvo Reality[13] or North Face VR[14] which both used Google Cardboard's platform to introduce their product in a novel and immersive way with VR. Google (with Cardboard and LG's VR for G3) and Oculus (with its Samsung Gear) will likely be competing to become the standard software technology for low-end VR devices.

LG's VR for G3 (Source: http://www.lg.com/us/mobile-phones/g3/vr)

High-end gaming-centered devices provide a more advanced range of functionalities, making the virtual world feel almost as real as the real world. These devices enable a more intricate interaction within the virtual world – for example, you can walk around or control objects within the virtual world using hand-held consoles. However, these devices require high computing power and are typically tethered to a computer, so mobility is restricted. The competition to become the dominant technology and device is fierce. Hardware players include Facebook (with its subsidiary Oculus), HTC (in collaboration with video game developing company Valve Corporation), and Sony (Play Station VR). While Facebook's Oculus Rift is considered the market leader at this point, it is still unclear who will be the final winner. All of these companies are launching new products to the market this year[15] with Oculus releasing its first product in March, and HTC in April.

In the ultimate high-end VR spectrum, products such as eMagin are appearing. As with many new disruptive technologies, the most cutting-edge development is going on through joint research with the military[16].

While VR certainly is the media's focus at this point, perhaps the more important applications will come from AR, which is slightly below the tech hype radar at this point. According to some forecasts, the AR market is going to outrun VR by 2019, with the forecasted revenue of AR being US$90B by 2020 compared to US$30B for VR[17]. Business implications are more significant as AR can be the hands-free computer for workers without a desk, such as doctors or construction workers. However the technology is not yet as mature as VR. The current available technology for AR is a crude version of what it could be in the future.

In terms of business models, there are clear signs that AR will be geared more towards Business-to-Business (B2B) applications, rather than B2C as in VR. The most well-known AR device, Google Glass (albeit not being the most technologically advanced) is an interesting case in point. The initial B2C launch back in 2013 was not all that successful. However the device has proven itself in multiple business applications. For example, Boeing technicians assembling wire harnesses for their commercial airplanes use Google Glass to overlay the technical instructions while doing actual assembly. Instead of reading paper manuals and relying on the individual worker's memory, Google Glass overlays the manual information on top of the actual assembly, enhancing accuracy and preventing human errors[18]. UPS is also using the device to speed up their package sorting process – sorters scan the address barcodes to directly access the optimal delivery route information[19]. Based on these results, Google has recently pivoted its approach and is re-launching Google Glass with an enterprise-focus[20].

Among the VR/AR players, Microsoft has decided to take a different approach. The company is looking into AR opportunities through its pilot product, Hololens. Not yet launched to the public, it includes functionalities such as projecting holographic images integrated to the user's surroundings, tracking movements, reading hand gestures and identifying objects around the user[21]. Microsoft is looking into making applications for gaming[22], as well as introducing a holographic operating system[23]. However there are still major technical drawbacks, the most common criticism being that the range of vision is still too narrow[24] (as opposed to a wider range of vision provided through VR).

Image of a holographic touchscreen technology

Another possible game-changing product awaiting launch is from a secretive startup called Magic Leap. Last year the company made the news by receiving a whopping $542M investment led by Google, but public information of a potential product or services is still scarce. Rumors suggest the company is to use a technology called near-eye light-field display, which can give a realistic experience for the virtual graphics displayed. Their demo video[25], while criticized as being too unrealistic, succeeded in creating buzz and excitement for what may be coming.

VR will focus on entertainment and select industries; AR will become a productivity tool

VR and AR have partially overlapping use cases (like video games), while showing distinct use cases in other areas. We believe that VR will focus more on entertainment and select industries, while AR will have a wider more general use case as a productivity tool.

VR will be used for virtual tours, simulations of real-life situations, and 3D designing.

- *Virtual tours:* VR is starting to be used in real estate to show prospective buyers homes in an immersive way. Similarly, VR is also used for virtual tourism and experience-based education. VR provides value in these situations as it doesn't require the user to physically travel to a location to experience it. In the future we expect VR to be expanded to a wider range of use cases, such as live events (concerts or sporting events) or journalism (for example showing the 360 degree surroundings of a war zone to provide the full experience and feel of world events).
- *Simulation of real-life situations*: Already VR is used to simulate real-life situations that have high-risk. For example, it is used in the military to simulate raids, or used for training commercial airline pilots. It is also used in physical therapy to aid phobia patients with real-life simulations of their fears to overcome it. VR provides value in these situations as you can simulate the experience without having to deal with the risk. Applications will grow to new areas, such as driver's license training and testing, and vocational training involving exposure to dangerous situations (such as heavy machinery, factory, or construction site technical workers).
- *3D designing and engineering*: VR is disrupting the computer-aided design (CAD) industry, which traditionally relied on a 2D screen to project and visualizes 3D structures. Some leading companies in many fields (which can range from architect firms, automotive companies, to biomedical firms) are already using VR to visualize, design, and engineer its 3D products. VR adds significant value in this field, as it provides a much more realistic view of the 3D structure which enables the designers and/or engineers to create solutions more efficiently. We expect this technology to spread to a more wide variety of industry use cases, substituting expensive samples or mock-ups.

On the other hand, AR will be used more for hands-on education or productivity enhancement education.

- *Hands-on education*: Partially overlapping with real-life simulation use cases of VR, AR can provide the next step in education, providing guidelines and tips while actually carrying out a task in the real life. A few preliminary use cases already exist for AR education related to high-risk equipment handling[26]. AR is likely to be applied to more fields for education purposes, such as replacing cable installation manuals, or assisting automotive repair or plumbing tasks.

Productivity enhancement: As seen in the previous Boeing and UPS use cases of Google Glass, AR holds potential for significant productivity enhancement by having a powerful and purpose-driven hands-free device mounted on your head. The value proposition of AR is that it can pull needed data at the right time and right place, so you can compare that to the real world at any given situation. We expect more industry-specific and business-specific productivity enhancement use cases to emerge, especially for work scopes that rely on

individual worker's memory, such as quality control, assembly, or logistics sorting.

Widespread application in the next five years

Currently both VR and AR are still in somewhat of an early stage and proven business application cases are only starting to emerge. However there is much potential and technology is quickly catching up. Going beyond use cases, VR and AR have the potential to become the new standard on how we interact with computers—a big step forward from a keyboard, mouse and touch screen.

It may be too early to bet on which hardware/software will become dominant, but now is a good time to start experimenting and figuring out how it can benefit your business/industry. Pilot implementation could be done with low-end devices and applications, such as Google Cardboard and Sketchfab. Price of implementation will go down as the technology is adapted further and full-scale mass production of products begins. This is already underway, and this year that momentum will only build up further.

Further reading and references:

This blog is based on a broad range of articles and reports. Some of the more interesting ones are listed below. Note that VR and AR are fast-evolving with news on technology and new applications being updated daily. Some good resources to follow are online fan communities like the Oculus subreddit (https://www.reddit.com/r/oculus) or news publications dedicated to the subject like "Road to VR" (http://www.roadtovr.com/).

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