Virtual reality implementation: observations and predictions

Brian Dipert - December 05, 2018

It wasn't so very long ago that plenty of industry pundits were prognosticating that VR (virtual reality) was poised to be the "next big thing," driving sales of head-mounted displays (HMDs) and associated other hardware (and their silicon and other building blocks), software and other content, and the communications infrastructure connecting users' headsets to each other along with intermediary cloud resources. For a current reality check, however, take a look at a recent blog post from Palmer Luckey, who founded Oculus and sold it to Facebook for $2B USD in 2014, subsequently leaving in early 2017:

No existing or imminent VR hardware is good enough to go truly mainstream, even at a price of $0.00. You could give a Rift+PC to every single person in the developed world for free, and the vast majority would cease to use it in a matter of weeks or months.

I know this from seeing the results of large scale real-world market testing, not just my own imagination—hardcore gamers and technology enthusiasts are entranced by the VR of today, as am I, but stickiness drops off steeply outside of that core demographic. Free is still not cheap enough for most people, because cost is not what holds them back actively or passively.

As Ars Technica's coverage also notes, "Luckey goes on to estimate that current VR technology could attract an absolute ceiling of 50 million active users worldwide, and that only with significant industry effort. That's a far cry from the 1 billion users Facebook CEO Mark Zuckerberg cites as his long-term goal for VR adoption."

I'd argue that Zuckerberg still isn't wrong, specifically depending on what he means by "long-term." One needs only look at the compelling vision for VR presented in the movie Ready Player One or, I'd suggest, the far superior novel the film was based on. But if Luckey's right (and I definitely think he is, too), the platforms are going to need to evolve and otherwise mature pretty significantly from where they are now in order for this goal to be achieved. Understanding where hardware needs to go requires first understanding where it is now. So let's dive in (at least a bit), and look at the three main VR implementation categories that I see.

Computer- and game console-based VR

The intent here is leverage the substantial graphics and primary processing horsepower (not to mention memory and other abundant resources) of a tethered computer or console system you already own, in order to limit the cost (and size, weight, etc ... since, after all, it's strapped onto your head) of the VR headset itself. Examples here include the well-known Oculus Rift, as well as HTC's Vive and more recent Vive Pro, and Sony's Playstation VR for the Playstation 4. Conceptually, at least, the strategy's sound, but the "devil's in the details," as the saying goes. For one thing, not
everyone has a sufficiently robust computer (far from a Playstation 4), or is willing to purchase/upgrade to one just for VR purposes.

Equally if not more important is that word "tethered" that I used earlier. A fast, low-latency data link between the headset and system to which it's connected is necessary, both to transfer various sensor-captured data from the headset to the computer or game console, and then to transfer processed audio, video, and graphics information back to the HMD. For now, at least, that connection is wired, thereby limiting the range in which a VR user can roam away from the tethered system and otherwise complicating the setup. 60 GHz Wi-Fi (i.e. IEEE 802.11ad) and other leading-edge high-speed wireless protocols may help here (and prototypes already exist), but these technologies' limited range in free space (not to mention their high likelihood of both intermediary absorption and multi-path distortion) will complicate the aspiration for reliable high-volume implementations.

And then of course there's still the need to supply the HMD with power; "cutting the cord" will necessitate heavy, bulky built-in batteries instead (no, I'm not holding my breath on long-distance wireless power delivery ... and no, I don't find backpack PC-based VR to be a credible solution for the masses, either). For these and other reasons, I'm skeptical that computer- and game console-based VR will be much more than a near-term stopgap solution to the VR implementation problem, no matter that early adopters may scorn my stance. This particular approach won't completely disappear, mind you, but it won't be the primary path to widespread adoption. Oculus apparently agrees; the company has reportedly shelved (at least temporarily) its planned "Rift 2," resulting in the departure of co-founder (with Luckey) Brendan Iribe.

**Smartphone-based VR**

On the other end of the implementation spectrum, albeit conceptually similar from the standpoint of "leveraging the system resources found elsewhere," is the idea of attaching a smartphone to the front of a head-mounted viewer. The idea first gained traction at Google's mid-2014 Developer Conference with the low-cost Cardboard HMD; regular readers may recall that I later mentioned I was test-driving a few foam-based and otherwise fancier Cardboard-based products from Anywhere, I Am Cardboard, PowisVR, Unofficial Cardboard, Knox Labs, and others (I even snagged a R2-D- themed freebie from Verizon and Disney).
Unsurprisingly, the concept has advanced since then. There's Samsung's Gear VR headset family, for example, intended for use solely with the company's various smartphones and "phablets." And then there's Google's two-generation Daydream View headset line, two first-generation examples of which accompanied my Google Pixels as promo freebies when I bought the smartphones in late-summer 2017:
The advantages of this particular approach are multiple and notable. As with the PC- or game console-tethered setup, you're leveraging the abundant hardware (including high-speed cellular data) and software resources of something else, in this case something you likely already own (or will soon, given the still-rapid pace of mobile electronics evolution). Since this type of VR has at its foundation the high-volume smartphone platform, the installed (therefore potentially accessible) customer base is substantial and easily "sold," leading to low-price implementations. Depending on how the HMM is designed, the smartphone's rear camera may be exposed to the outside world, enabling 6 DOF (degree of freedom) implementations derived from external frames of reference, along with augmented and mixed reality applications in addition to VR. And, of course, there's no wired tether; among other things, it harnesses the batteries built into the smartphone.

Downsides can't be ignored, however. While the smartphone is clipped into the HMD, it can't be used for anything else: no multitasking for you! Headsets can be front-heavy with the smartphone inside them unless carefully designed. There's the potential for optical distortion, along with narrow DOF (depth of field); Wikipedia's Google Cardboard entry notes, for example, that a "compatible app splits the smartphone display image into two, one for each eye, while also applying barrel distortion to each image to counter pincushion distortion from the lenses." The whole approach is a bit "geeky" or "wonky," IMHO, which in and of itself may result in consumer pushback. And it's processing-intensive, rapidly draining the battery of the smartphone, which subsequently can't be used for other functions until it's adequately recharged.

"Wonkiness" aside, I'm pretty optimistic about this particular VR approach long-term, simply because of its low cost of entry and because it leverages a platform (the smartphone) that you already own. **Standalone VR**

While Facebook Oculus may be putting the brakes on development of its next-generation PC-tethered HMD, it's full-steam ahead on standalone platforms, for (I'd argue) good reason. Consider
these as smartphones-plus-visors (as previously described) absent non-essential hardware and software, and merged in a fully integrated design (including batteries). A few months ago, for example, I picked up the 64GB version of the Oculus Go for just over $200 thanks to a 15%-off Ebay promotion (normal price $249). I've not used it much yet, but reviews are solid; here are some snapshots of the headset and its companion controller to whet your appetite until my testing is more fleshed out:
The Oculus Go is based on Qualcomm's Snapdragon 821 SoC, and its integrated accelerator, gyroscope, and magnetometer support head-only position, orientation, and motion tracking in three degrees of freedom. Its most direct competitor is Lenovo's Mirage Solo, the initial implementation of Google's full-blown standalone Daydream platform. The Mirage Solo supplements integrated IMU (inertial measurement unit) sensors with both inward- and outward-focused image sensors that track the user's body as it moves through free space, thereby supporting full 6 DOF. The Mirage Solo is also based on the newer, beefier Snapdragon 835 and offers a slightly wider FOV (field of view) ... in exchange, it costs roughly twice as much as the Oculus Go.
Oculus has a more direct competitor to the Google Daydream platform, the 6 DOF-supportive **Oculus Quest**, under active development. And HTC's competitive HMD, the Snapdragon 845-based Vive Focus, is now **available worldwide starting at $599** after an Asia-only initial release a year back. Other differences between the contending headsets include per-display resolutions and refresh rates ... along with, of course, their respective size, weight, battery life, comfort, and other factors.

**An unclear path forward**

Of the three leading approaches to implementing VR covered in this writeup, the standalone HMD is admittedly the most appealing alternative to me, conceptually at least. After all, it's the closest approximation of the VR prescience portrayed in *Ready Player One*, not to mention the grandfathers of VR prose, William Gibson's *Burning Chrome* and *Neuromancer*, and Neal Stephenson's *Snow Crash*. But I'm hesitant to predict that it'll definitively lead the market going forward. After all, there isn't *that* much difference between its bill-of-materials and that of a full-blown smartphone. And a multi-function smartphone is far more versatile; I've written before about how smartphones have already largely subsumed plenty of other fixed-function product categories, such as still and video cameras, and audio and multimedia players.

Perhaps what we'll end up seeing is an evolution of the smartphone, adding the ability to consume content and interact with others not only verbally and via text messages but also via VR in (to quote Gibson) *cyberspace* and (to quote Stephenson) the *metaverse*. What are your thoughts? Sound off in the comments.

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