

Exhibit 6

VR WEARABLE TECHNOLOGY FEATURE

Inside-out v Outside-in: How VR tracking works, and how it's going to change

Positional tracking is one of VR's most interesting challenges



Wearable is reader-powered. If you click through using links on the site, we may earn an affiliate commission. [Learn more](#)

Wednesday May 3, 2017

By **Hugh Langley** @hughlangley



Mobile VR has reached the point of delivering experiences that don't make us feel nauseous or short changed. No, you're not going to get the same level of quality as the [Oculus Rift](#) or [PS VR](#) - yet - but both technology and games are rapidly improving. It also allows us to cut the pesky cords, but the boom of mobile VR has also opened up new ways of thinking about six-degree-of-freedom (6DoF) in virtual worlds.

The ability to roam free in a (limited) space is what makes the [HTC Vive](#) the most compelling system on the market right now, but the way it uses positional tracking isn't necessarily best for everyone else. Oculus has a similar approach, but it's already announced plans for an upgrade that relies on inside-out tracking, without the wires, to afford much greater mobility. In fact, we had a play with the [Santa Cruz prototype](#) late last year.



FREE SHIPPING NO



NEWS

REVIEWS

SMARTWATCHES

FITNESS TRACKERS

FITBIT

Fitness tracker

Fitbit

Apple Watch

MORE



Meet
Big By Definition M

SHOP NOW ▶

You might have heard about inside-out and outside-in tracking, and you might already know what these mean. But what are the merits of each? And which is the one we'll be using in 10 years time?

Outside-in



If you've used one of the 'big three' systems - Oculus Rift, HTC Vive, PS VR - then you'll have seen outside-in tracking in action. This is where the headset and accessories are tracked by an external device. In the case of the Vive it's the Lighthouse sensors that are placed around the room. For the Oculus Rift, it's the positional tracker that sits pointed at the headset, likely by your computer display, and it's a similar setup for the PS VR camera.

In all of these cases, the camera(s) is placed in the room and determines the position of the headset in relation to its environment. While it's something we're seeing more in higher-end system, some mobile VR is also experimenting with outside-in solutions.

Pros

FREE SHIPPING NO



less likely you'll feel nauseous. Until we can get this level of power into lower cost hardware, outside-in will continue to be the most powerful form of tracking - that's why there's still benefits of outside-in for mobile VR.

Cons

- One of the main limitations is a problem called occlusion, which is the technical term for "stuff getting in the way". Should you suddenly vanish behind a couch or tall plant, and out of sight of the cameras, they'll have a harder time tracking you. It doesn't just have to be other objects: the sensors need to be able to track you effectively in 360 degrees, else they'll lose your placement the moment you turn around.
- The other big problem is the limitation of the cameras. Unlike inside-out, you're only tracked as long as you're in its field of view, and as soon as you step outside of that space the immersion dies. This can be particularly problematic if you have limited space for your VR setup.

Inside-out



In this scenario, the camera is placed on the device being tracked and looks out to determine how its position is changing in relation to the external environment. As the headset moves, the sensor re-coordinates its place in the room, giving the impression that you're moving through the virtual environment in real time. Inside-out tracking can be done with or without markers around the environment. While headsets like the Pico Neo CV offer the freedom to use them where you want, you may also recall that picture of a Valve demo room, where fiducial markers covered the walls in order to aid the inside-out tracking

FREE SHIPPING NO

solutions, including [Qualcomm's 835 reference headset](#), designed to help other manufacturers build their own systems. [Eonite also showed us](#) its inside-out solution, a sensor attached to a HTC Vive that, while still wired, allowed us to roam freely in the virtual world without any sensors around the room. The big one though is Microsoft, which is using inside-out in HoloLens as well as its upcoming Holographic headsets, including the [Acer 'mixed reality' HMD](#).

Pros

- Freedom! With inside-out you're not restricted to a play space, so mobility is increased and the virtual feels a bit more... real.
- For augmented and mixed reality, inside-out tracking will become essential as we demand more mobility from the systems.

Cons

- Accuracy and latency. Inside-out tracking requires good computer vision, and this technology is a little further behind outside-in solutions, but it's getting there.
- All computational work must be done by the headset itself.

So where is all this going?



Perfectly accurate inside-out tracking is the holy grail of all the "realities". After all, who wants to be leashed to a computer like a misbehaved dog when exploring far-flung universes in VR?

"I suspect we may see outside in continue to exist only in the high-end desktop PC part of the market (Vive) as the absolute

FREE SHIPPING NO

Explore Litigation Insights

Docket Alarm provides insights to develop a more informed litigation strategy and the peace of mind of knowing you're on top of things.

Real-Time Litigation Alerts



Keep your litigation team up-to-date with **real-time alerts** and advanced team management tools built for the enterprise, all while greatly reducing PACER spend.

Our comprehensive service means we can handle Federal, State, and Administrative courts across the country.

Advanced Docket Research



With over 230 million records, Docket Alarm's cloud-native docket research platform finds what other services can't. Coverage includes Federal, State, plus PTAB, TTAB, ITC and NLRB decisions, all in one place.

Identify arguments that have been successful in the past with full text, pinpoint searching. Link to case law cited within any court document via Fastcase.

Analytics At Your Fingertips



Learn what happened the last time a particular judge, opposing counsel or company faced cases similar to yours.

Advanced out-of-the-box PTAB and TTAB analytics are always at your fingertips.

API

Docket Alarm offers a powerful API (application programming interface) to developers that want to integrate case filings into their apps.

LAW FIRMS

Build custom dashboards for your attorneys and clients with live data direct from the court.

Automate many repetitive legal tasks like conflict checks, document management, and marketing.

FINANCIAL INSTITUTIONS

Litigation and bankruptcy checks for companies and debtors.

E-DISCOVERY AND LEGAL VENDORS

Sync your system to PACER to automate legal marketing.